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FRIDAY, JULY 14, 1899.

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*THE STRUCTURE OF PROTOPLASM.**

IT would be superfluous to dwell in this place on the deep and enduring interest that attaches to the microscopical study of protoplasm. Since the time when the studies of Cohn and Schultze led to the general recognition of protoplasm as the material substratum of vital activity—a conclusion so eloquently set forth by Huxley in his celebrated essay on the physical basis of life—this interest has continually increased, as we have come to see even more clearly that all biological phenomena are directly or indirectly traceable to the effects of protoplasmic activity, for we have thus been impelled to seek for an understanding of that activity in the morphological structure of protoplasm, as revealed by the microscope. It is small wonder that to this quest some of the ablest of modern biologists have devoted their best energies. And yet, if we take account of the actual

* This lecture is printed by permission of Professor C. O. Whitman, Director of the Biological Laboratory at Wood's Holl, and Messrs. Ginn & Co., the publishers of 'Biological Lectures delivered at the Marine Biological Laboratory, 1889–99,' in which it will appear. A more adequately illustrated special paper on the subject, containing more specific references to the literature, is now in press. It should be borne in mind that such delicate textures as those seen in the protoplasm of living cells cannot be properly illustrated by black and white figures. The accompanying text figures, though copied as accurately as possible from the original drawings, are of necessity relatively rude and schematic.

knowledge gained, we cannot repress a certain sense of disappointment, partly that microscopical research should have fallen so far short of giving the insight for which we had hoped, but still more because of the failure of the best observers to reach any unanimity in the interpretation of what is actually visible under the microscope. In any consideration of the general subject, therefore, it is well to keep clearly in view the fact that such disagreement exists, and that we are not yet in a position to justify any very certain or far-reaching conclusions.

I would like, at the outset, to express the opinion that, if we except certain highly specialized structures, the hope of finding in visible protoplasmic structure any approach to an understanding of its physiological activity is growing more, instead of less, remote, and is giving way to a conviction that the way of progress lies rather in an appeal to the ultra-microscopical protoplasmic organization and to the chemical processes through which this is expressed. Nevertheless, it is of very great importance to arrive at definite conclusions regarding the visible morphology of protoplasm, not only because of its intimate connection with all the problems of cell-morphology, but also in order to find the right framework, as it were, for our physiological conceptions, and thus to gain suggestions for further physiological and chemical inquiry. And this must be my excuse for reviewing a subject which is still so largely obscured by doubt, and of which the outcome gives, after all, so little satisfaction.

It is especially important in this field of biological inquiry to distinguish clearly between theory and observed fact, for theories of protoplasmic structure have always far outrun the actual achievements of observation. From the time of Brücke (one of the first to insist that protoplasm must possess a far more complicated organization than that visible under the microscope) speculation has gone steadily forward, to reach, perhaps, its most elaborate expression in Weismann's interesting, but unconvincing, work on the germ-plasm—an elaborate speculative system built out of hypotheses which, for the most part, float in the air without visible means of support. We need not consider this side of the subject *in extenso*, but I will ask attention, for a moment, to what is the most characteristic and, to the morphologist, the most interesting point in these speculations, namely, the doctrine of genetic continuity as applied to the corpuscular, or micellar, theory of protoplasm. We are all familiar with the successive steps by which that doctrine gradually developed. Harvey's celebrated formula, *ex ovo omnia*—or, as usually quoted, *omne vivum ex ovo*— took with Redi the far more philosophical form, *omne vivum e vivo*, thus expressing a truth which forms the very foundation of all biological teaching at the present day. The development of the cell-theory, long afterwards, enabled Virchow to pronounce the more specific aphorism, *omnis cellula e cellula* (1855), a statement involving the highly interesting conclusion that protoplasm is never formed *de novo*, but always arises from or through the activity of preëxisting protoplasm differentiated into the form of a cell. Still later a like conclusion was reached with respect to at least one of the structural components of the cell, namely, the nucleus, and the work especially of Flemming and Strasburger justified the saying, *omnis nucleus e nucleo*. Not long afterwards, the researches of Schmitz, Schimper and others showed that in plant cells some, if not all, forms of plastids (for example, the chlorophyll-bodies) likewise arise by the division of preëxisting bodies of the same kind. Thus the law of genetic continuity was gradually extended downwards from the grosser and more obvious characters of the organism

into the finer details of its structural elements. Genetic continuity, the origin of like from like, may now safely be regarded as a demonstrated fact in the case of all existing organisms and of all cells; it hardly falls short of the same degree of certainty as applied to the nucleus; it is probable in the case of various forms of plastids in plant cells; while the centrosome is now being weighed in the balance with the evidence for the moment apparently accumulating on the negative side.

Up to this point we have been dealing with matters of observed fact. The next and final step was, however, taken in the region of pure speculation, which had in the meantime been at work building upwards from hypotheses regarding the basic composition of protoplasm. Brücke's suggestion, that the cell might be a congeries of bodies more elementary than itself, found a much fuller expression in Herbert Spencer's theory of physiological units; but it was Darwin's theory of pangenesis that laid the real basis for what followed in the works of De Vries, Wiesner, Weismann and Hertwig. The common feature in all these later views is the conception of protoplasm, not as a homogeneous substance or mixture of substances, but as made up of a host of elementary ultra-microscopical corpuscles ('pangens,' 'biophores,' etc.), specifically different, capable of assimilation, growth and multiplication, and arising by division of preëxisting bodies of like kind. Developed as a purely theoretical hypothesis, and within somewhat narrower limits by Darwin, this conception was expanded and brought into more direct relation with observed fact, especially by De Vries and Wiesner, who showed how the assumption of such elementary self-propagating corpuscles at the basis of living matter enabled us to bring all the observed phenomena of genetic continuity under a common point of view. The fundamental hypothesis itself —*i. e.*, the genetic continuity of the ultimate morphological units—has, however, always remained, and still remains, a pure assumption, incapable of direct proof or disproof; for, with the exception of Altmann and a few of his followers, all are agreed that such elementary corpuscles, if they exist, must lie beyond the limits of microscopical vision. Altmann, however, has sought to identify the elementary units, or 'bioblasts,' with the visible protoplasmic granules; and, in his writings, the series of Latin aphorisms initiated by Redi culminates in the saying, *omne granulum e granulo* (!), but this conclusion has not been taken very seriously by most other investigators.

I have given this very brief sketch of the theoretical side of the question merely as an introduction, and shall dwell no farther on it at this point, since my main purpose is to ask attention to the visible, as opposed to the hypothetical invisible, structure of protoplasm. A subject so vast, displaying so great a conflict of opinion, must be very briefly treated within the limits of a single lecture; and I shall, therefore, confine the discussion in the main to the protoplasm of the echinoderm-egg, which is accessible to every one, has been made a classical object through the studies of such leaders of research as Flemming, Bütschli and Hertwig, and illustrates as clearly, perhaps, as any other the various interpretations of protoplasmic structure that have been given.

In thin sections of well-preserved material the protoplasm of a star-fish or sea-urchin egg gives the appearance, under a high power, of a fine meshwork or framework composed of innumerable minute granules, or *microsomes*, suspended in a clearer, less deeply staining, continuous substance (Figs. 1, *a*, and 4). The spaces of the meshwork, which measure from one to nearly two microns, are occupied by a third substance, clear, homogeneous, and

of only slight staining capacity, which has often been called the *ground-substance*. During cell-division the meshwork in the neighborhood of the dividing nucleus assumes a radiating appearance, giving rise to the so-called asters, or astral systems which are typically double, forming the *amphiaster* (Fig. 3, *b*). We may define the problems suggested by these appearances by a series of questions as follows:

1. What is the actual structure that gives the appearance of a meshwork?

2. How faithfully does the preserved structure, as seen in sections, reproduce that existing in life?

3. What is the relation of the astral systems to it?

4. What is the finer structure and origin of the meshwork?

5. Can this structure be taken as typical of all protoplasm; and if not, what is its relation to other forms of protoplasmic structure?

After seeking for answers to these queries, we may finally inquire how they bear on the theoretical views briefly reviewed above.

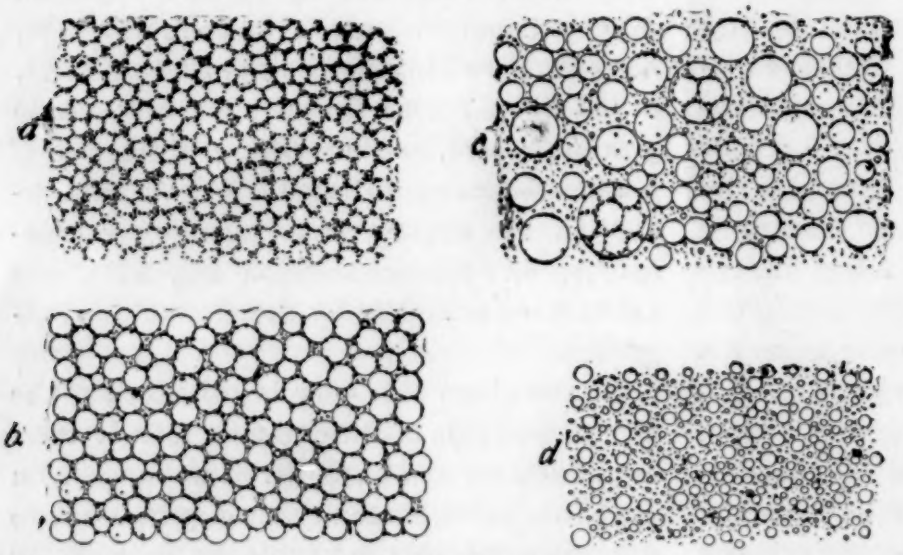

FIG. 1. (*a*) Protoplasm of the egg of the sea-urchin (*Toxopneustes*) in section; (*b*) protoplasm from a living star-fish egg (*Asterias*); (*c*) the same in a dying condition after crushing the egg; (*d*) protoplasm from a young ovarian egg of the same. (All the figures magnified 1,200 diameters.)

Incidentally, still another interesting question arises, namely: Is it possible to identify any one of the three elements in question—granules, continuous substance, ground-substance—as the *living* substance or *protoplasm* proper, as distinguished from a lifeless *metaplasm*, and, if so, what are its structural relations?

Could we positively answer all these questions we should have taken a long step forwards in the study of the cell. Far from this, however, in point of fact, hardly any two observers have given exactly the same answers to them. Leaving aside the earlier views, we find in the recent literature of the subject two principal general views with a number of modifications of each.

The first of these agrees with the early view of Klein and Van Beneden, that the protoplasm forms a net-work, *reticulum*, or thread-work, composed of branching fibers embedded in a homogeneous ground-substance which fills the interstices of the network, and with granules or microsomes lying along the course of the threads or at the nodes of the network. Many of those who adopt this interpretation further agree with their predecessors that the astral systems formed during cell-division arise directly through a rearrangement of the preexisting network, about active centers of attractive or other forces, somewhat as iron-filings arrange themselves along the radiating lines of force in a magnetic field—an arrangement which bears a remarkably close though only superficial resemblance to the protoplasmic amphiaster. Boveri and some others, however, regard the astral system as having no direct relation to the preëxisting network, believing that the rays either arise from a specific substance ('ar-

choplasm'), distinct both from the general network and from the ground-substance, or are wholly new formations which, as it were, crystallize afresh out of the protoplasmic substance.

The second view is that of Bütschli, who believes it to be applicable to all forms of protoplasm, and who has been followed by a considerable number of recent investigators. Bütschli's interpretation differs entirely from the foregoing, the meshwork being regarded not as a network, but as an appearance resulting from the optical section of 'alveolar' or emulsion-structure. The spaces of the meshwork are drops of liquid occupying spherical spaces, or 'alveoli'; the 'fibers' are optical sections of the thin layers, or lamellæ, by which the drops, or alveoli, are surrounded. Even the astral systems receive the same interpretation, the astral 'rays' and 'spindle-fibers' being an optical illusion resulting from the radial arrangement of the alveoli, and hence of the inter-alveolar septa by which they are separated.

The greater number of observers of protoplasm have given their adherence to one or the other of the two widely dissimilar views just outlined, though there are others to which we shall return later. Some investigators have taken a position intermediate between these two extremes. Thus Reinke has maintained that the cytoplasm of the echinoderm-egg is alveolar, as described by Bütschli (though, as will appear beyond, he ascribes to this structure a different physiological interpretation), while the astral systems are fibrillar, as held by Van Beneden, and arise as new formations at the cost of the alveolar walls. More recently, Strasburger has developed the related, but still different, view that the cytoplasm of the cell at large consists of two distinct substances, namely, the *trophoplasm*, or general nutritive plasma, which is alveolar, and the *kinoplasm*, or the substance active in division, which is fibrillar and gives rise to astral systems consisting of true rays and fibers.

It is remarkable that the best observers, working in many cases at the same object, should have reached conclusions so diverse. It is obvious, further, that in the face of such contradictions it is impossible to give any discussion of the subject that is not more or less strongly tinged with the personal views of the writer. Such views, by whomsoever expressed, can at present have no more than a provisional value; and this is the last subject on which dogmatism should be allowed. It is with full recognition of these difficulties that I venture to state some of my own conclusions, partly because they may serve to explain, in some measure, to those who have not specialized in this field, how the existing diversity of opinion has arisen, partly because they have perhaps some bearing on the more general questions that were referred to at the outset. I shall take up in order the questions raised above.

The Nature of the Meshwork.—Although in earlier papers I was inclined to regard the meshwork of the echinoderm-egg as a reticulum, further studies have left no doubt whatever, in my opinion, that in the resting cell it is in reality an alveolar structure—or, as I do not hesitate to call it, an *emulsion*—such as Bütschli has described. I was first led to this conclusion through the study of sections of the eggs of sea-urchins (*Toxopneustes*) and star-fish (*Asterias*); but whatever doubt may have remained was completely dissipated by the study of the living eggs of *Asterias* (Fig. 1, *b*), *Echinarachnius*, *Arbacia*, *Ophiura* (Fig. 2, *a*), under high powers. All of these eggs give in life essentially the same appearance, though no two are exactly alike. In all, the protoplasm consists of innumerable closely crowded minute spheres suspended in a clear basis. The spheres may be called the alveolar spheres, or, more

briefly, the *alveoli*, though, strictly speaking, the latter term should designate the cavities which the spheres fill. The clear basis in which they lie, and which forms the interalveolar walls, may, with Mrs. Andrews, be called the *continuous substance*. Scattered about in the walls are numerous granules, or *microsomes*, far smaller than the alveoli, which often give the appearance of an irregular network. If now we compare these appearances of the living protoplasm with those seen in the sections mounted in balsam we find at first sight very considerable differences. More critical study shows, however, that the differences are almost wholly due to the effect of differential staining and to the difference of refractive index in the mounting media in the two cases. The alveoli of the living protoplasm form the spaces of the meshwork. The latter consists of the continuous substance with the granules suspended in it. In the section what especially strikes the eye is the meshwork; for the alveolar spheres do not stain, and their contours become indistinct in the highly refracting balsam, while the continuous substance stains slightly, and the granules intensely, thus giving the appearance of a conspicuous granular meshwork. We thus arrive at a definite answer to two of the questions propounded above, namely: (1) the meshwork shown in sections is not a network, but the expression of an alveolar or emulsion-structure, and (2) proper fixation does not produce a mass of coagulation-artefacts, but preserves the visible structure very nearly as it exists in life.

The above conclusions are based mainly on the study of star-fish eggs, but are confirmed by the facts observed in other forms. In *Arbacia* the emulsion is considerably finer, the alveoli measuring on an average no more than 1.0 micron, while the finer granules are relatively less numerous. The pigment-granules characteristic of this form appear to be nothing other than modified alveolar spheres. In *Toxopneustes* the alveoli measure approximately from 1.0 to 1.3 microns, while the granules are more numerous than in *Asterias*. In *Echinarachnius* the alveoli are less uniform in size than in *Asterias*, the largest measuring up to about 1.7 microns, while the granules are less numerous. The egg of *Ophiura*, finally, has an extremely coarse structure, the alveolar spheres measuring on an average 3.0 to 4.0 microns, while the granules, or microsomes, are also very large and, in the superficial layers of the protoplasm, even more numerous than in *Toxopneustes*. The protoplasm of *Ophiura* (Fig. 2) is highly favorable for study, not only on account of the great size of its elements, but also by reason of the remarkable fact that these elements are colored in life, the alveolar spheres being in most individuals distinctly of an olivaceous or pinkish-brown color, while

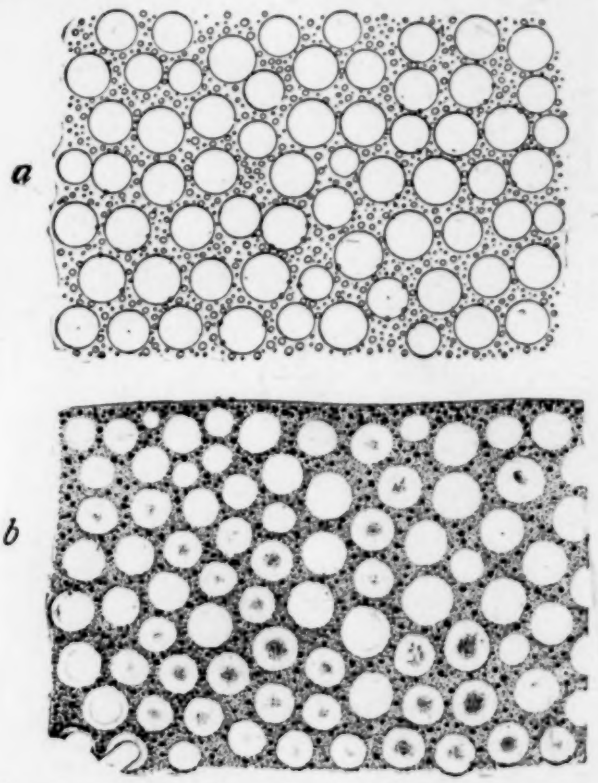

Fig. 2. (*a*) Protoplasm from a living ophiuran egg (*Ophiura*), slightly compressed, so as to spread the yolk-spheres somewhat apart; *b* the same as seen in a section (sublimate-acetic, iron-hæmatoxylin; 1,200 diameters).

the larger granules, or microsomes, are lemon yellow. This circumstance makes possible an observation of great importance, namely, that *all the elements of the protoplasm are liquid or viscid*. If the eggs of *Ophiura* be crushed by pressure on the cover-glass the protoplasm flows out, most of the alveolar spheres going in advance, while the granules and continuous substance lag behind. Meanwhile, the alveolar spheres often run together to form larger drops of all sizes, the origin of which is placed beyond question by their color. The same is true of the yellow microsomes, though this takes place less readily, and only under somewhat rough treatment. This demonstrates the liquid, or at least viscid, nature of both the spheres and the microsomes, and no less certainly that of the continuous substance in which both lie. As far as the alveolar spheres are concerned, the same observation may readily be made in the colorless protoplasm of *Asterias* (Fig. 1, *c*), *Echinarachnius*, or *Arbacia*, but I could never satisfy myself of the liquid nature of the microsomes in these forms. The case of *Ophiura* renders it highly probable, however, that the granules are liquid in these forms also—a conclusion which I confess was a surprising result to me; for we are so accustomed from our studies on sections to regard the granules as solid bodies that we are apt to forget that sections show us only coagulated material.

To sum up, a critical study of the living protoplasm of echinoderm-eggs shows that it is a liquid, or rather a mixture of liquids, in the form of a fine emulsion consisting of a continuous substance in which are suspended drops of two general orders of magnitude and of different chemical nature, as indicated by their staining reactions. The larger drops, forming the alveolar spheres, stain only slightly in hæmatoxylin, and constitute the so-called 'ground-substance' in the spaces of the meshwork; these have an average size, ranging in the various forms studied from 1.0 micron or less (*Arbacia*) up to 4.0 microns (*Ophiura*). The smaller drops, forming the granules or microsomes, are very much more minute, and stain intensely with iron-hæmatoxylin. The presence of the larger drops determines the primary alveolar structure as described by Bütschli. The smaller drops ('granules') lying between these give rise to the 'secondary,' or finer alveolar, structure as described by Reinke, and subsequently by Mrs. Andrews, as I understand these authors.

Relations of the Astral Rays to the Meshwork.—We may now make a brief digression to consider the third question propounded above, namely: What is the relation of the astral rays and spindle-fibers to the alveolar substance? It is easy to see, both in sections and in living material, that in a well-developed aster the alveoli are arranged in radiating lines between the astral rays (Fig. 4), precisely as Bütschli and so many others have described. The rays themselves are, however, something more than the radially arranged inter-alveolar septa, for, in the first place, they are often much thicker than these septa, and, in the second place, they stain more intensely than the continuous substance. A careful study of the rays in the echinoderms, and in many other forms (especially in *Nereis*, *Thalassema*, *Lamellidoris* and *Ascaris*), leaves, I think, no room for doubt that, in sections at least, the rays are actual branching fibrillæ, as described by so many observers since the time of Van Beneden, that thread their way through the continuous substance between the alveoli, often in a zigzag course. The strongest evidence that they are fibrillæ is given by the appearance of the cut ends of the rays as they appear in somewhat excentric or rather thick sections of the asters. In such sections, particularly in the case of large and coarse asters like those of *Nereis* (Fig. 3, *b*), the rays may be

seen in the clearest manner to terminate as they pass upwards towards the eye in well-defined cut ends, and I think no one who studies these preparations can doubt that in them the asters are true fibrillar structures.

We may now inquire in what manner the rays arise and grow, and what is the origin of their substance. In the growing aster

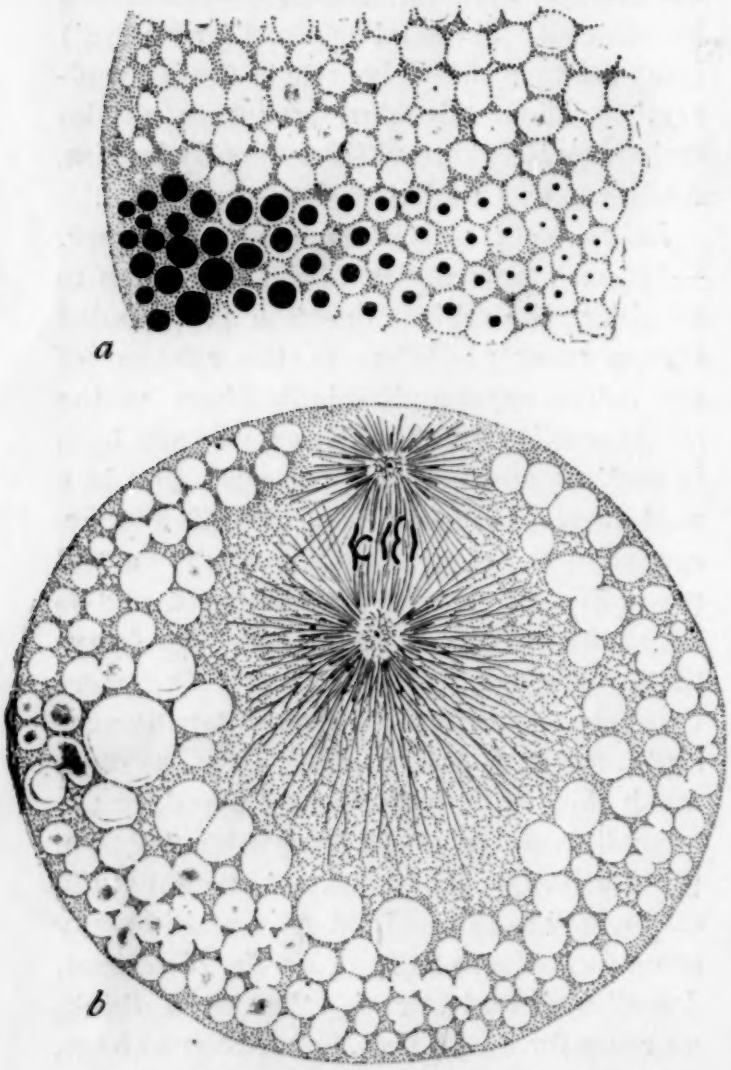

FIG. 3.—(*a*) Protoplasm and yolk-spheres from the egg of *Thalassema* in section. The upper part of the section shows the result of prolonged extraction of the dye (iron-hæmatoxylin); the lower half represents varying degrees of extraction (1,200 diameters); (*b*) egg of *Nereis* in section showing yolk-spheres and the first polar amphiaster above (600 diameters).

the rays progressively extend themselves from the center outwards, gradually losing themselves in the general meshwork. It has been maintained by some writers that the rays grow outwards from their bases like the roots of a plant, and in a certain sense this is undoubtedly true. But it is difficult to believe that all of the material of the rays comes from the base, *i. e.*, from the nucleus or the centrosome, for they often extend themselves throughout the entire cytoplasm, even in cases where, as in the sperm-aster of echinoderms, the center of the aster remains very small, and the nucleus still consists of a compact mass of chromatin (Fig. 4). It is more probable that they grow at the tip, continually extending themselves at the cost of the material lying in the meshwork. When the rays are followed out peripherally they may often be seen to run out into rows of granules like beads on a string. Van Beneden, who has been followed by many later writers, was inclined to regard the rays as essentially rows of microsomes strung together by a homogeneous, clear substance, *i. e.*, by the continuous substance, and I was led to the same conclusion in the case of sea-urchin eggs. A study of the asters in *Ophiura* throws doubt upon this conclusion, for it is here certain that the larger and deeply staining microsomes do not build up the ray, but are quite irregularly scattered along its course. The rays here mainly arise, I believe, in, and at the expense of, the continuous substance, and the linear arrangement of the microsomes is incidental to the differentiation of this substance along a definite tract which more or less involves the microsomes as it progresses. This conclusion probably also applies to other forms. The material active in the ray-formation appears to be the continuous substance, and, while the microsomes may, and probably in many cases do, contribute to the ray, they probably play the part of reserve material rather than of active elements.*

*As already pointed out, we cannot assume that the ray is *merely* an accumulation of the continuous substance on account of its different staining capacity.

To sum up, the general result indicates that the opinions regarding the aster-formation referred to above can in a measure be reconciled. In the case of echinoderm-

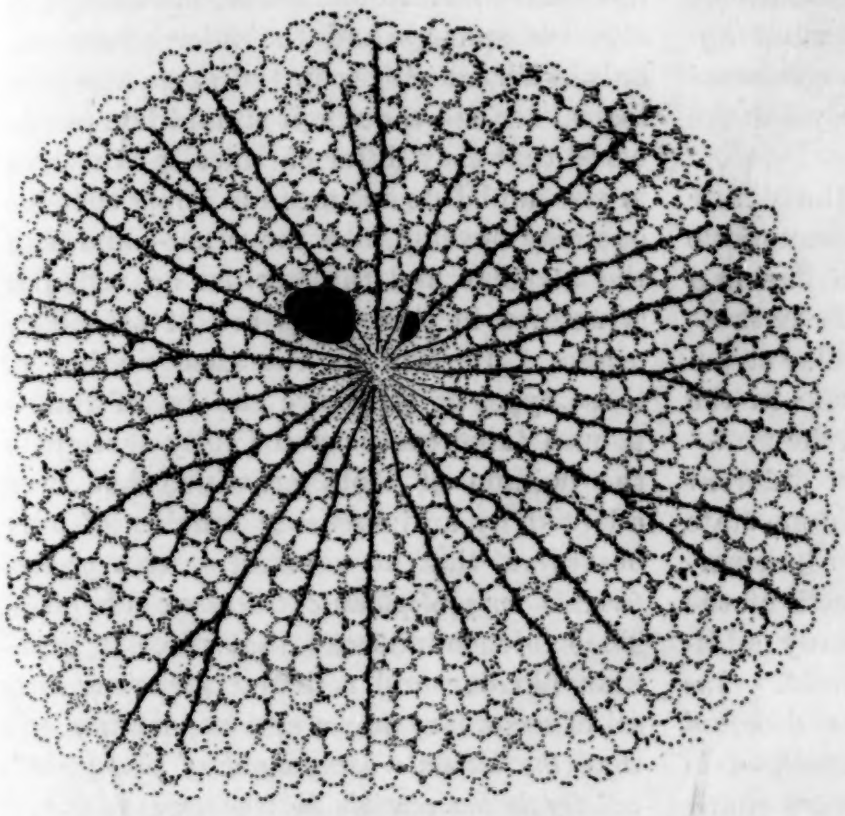

FIG. 4.—Section of sea-urchin egg (*Toxopneustes*), 1½ minutes after entrance of the spermatozoön, showing sperm-nucleus, middle piece and aster (about 2,000 diameters).

eggs Bütschli and Erlanger correctly describe the aster as involving a radial arrangement of the alveoli, but they have failed to recognize the fibrillæ that lie between them, and Boveri is, therefore, thoroughly justified in the contention that the astral systems cannot be regarded as merely a radial configuration of the preëxisting meshwork. I, nevertheless, think that Hertwig, Reinke and myself were right in the contention, which has been made also by many others, that the rays grow by progressive differentiation out of the general cytoplasmic meshwork, and that there is no ground, in the echinoderm-egg at least, for the recognition of a specific 'archoplasm' or 'kynoplasm' from which they arise.

Finer Structure and Origin of the Meshwork.—We may now consider what is, I think, the most suggestive of the questions propounded, namely, that relating to the finer structure and origin of the mesh work. We have thus far distinguished sharply between alveolar spheres, granules, or microsomes, and continuous substance. Morphologically considered, however, there is good reason for the view that all these are but different gradations of one structure. In the first place a nearly or quite complete series of size gradations exists between the largest alveoli and the microsomes (Fig. 1, *b*, *c*). Although most of the alveoli vary but slightly in size from the mean, a little search shows the presence of many smaller ones, and here and there they seem almost, if not quite, as small as the larger microsomes. In the second place, careful study of the 'continuous' substance in life, especially in the crushed protoplasm, shows that the larger microsomes in turn graduate down to granules so small as to lie near or at the limit of microscopical vision. The 'continuous' substance is, in other words, filled with granules, *i. e.*, drops of all sizes, ranging from the smallest visible ones up to the largest alveoli. It is this fact which Mrs. Andrews, as I understand her statements, has in view in maintaining that the coarser alveolar structure "is not, indeed, the final structure of the living substance, but is part only of an infinitely graded series of vesiculations of the protoplasmic form" and with this statement I entirely agree. But we cannot stop here. Irresistibly the further question suggests itself: Why should we place the end of this series at the end of microscopical vision

under a 1.5 mm. immersion objective—which is, of course, a perfectly arbitrary and artificial limit? It is impossible to doubt that powers still higher than any at our command would reveal the existence of granules still smaller, and that what appears as 'continuous' or 'homogeneous' substance is itself an emulsion beyond the range of vision.

We may now inquire whether the coarser visible alveolar structure is characteristic of all protoplasm. This question has in a measure already been answered, for in these very eggs we have seen the alveolar structure giving rise to a fibrillar one in the aster-formation—in other words, the protoplasm of the same cell may in different phases pass back and forth from one state into another. This fact appears in its clearest form when we study the growth of the ovarian ova, which gives us many additional suggestions of high interest. *The entire coarser alveolar structure, as described above—i. e., the foam structure of Bütschli—is in these eggs of secondary origin.* The very young living ovarian eggs consist of 'homogeneous' protoplasm, such as has been described by many botanists in the embryonic tissue-cells, through which are irregularly scattered a few small spheres and many excessively small granules. As growth proceeds both the spheres and the granules increase in size, the latter enlarging to form new spheres, while new granules continually emerge from the protoplasmic background into the limits of vision. In the middle stages of growth the protoplasm is thus converted into an emulsion, being filled with spheres of all sizes, ranging downwards from 1.0 micron to the smallest granules, but still showing no regular arrangement (Fig. 1, *d*). As the egg approaches maturity the spheres become differentiated into two groups, the larger ones becoming approximately of the same size, to form the alveolar spheres and crowding together, while the smaller ones remain as the microsomes and finer granules embedded in the remains of the continuous substance which forms the basis of the meshwork. In one sense, therefore, the alveolar spheres and the microsomes are only different stages in the same morphological series—though it should be remembered that they differ chemically as well as in size, and I do not mean to imply that the one may develop into the other—and both the alveolar and the fibrillar or reticular structures in these eggs are of secondary origin. If this be the case neither of these types of structure can be of fundamental importance; and I fully agree with the opinion of Kölliker, which has been adopted by an increasing number of later observers, that *no universal or even general formula for protoplasmic structure can be given.* The evidence indicates that alveolar, granular, fibrillar and reticular structures are all of secondary origin and importance, and that *the ultimate background of protoplasmic activity is the sensibly homogeneous matrix or continuous substance* in which those structures appear.

I do not mean to say that this is the only 'living' element in the cell. The distinction between 'living' and 'lifeless,' between 'protoplasmic' and 'metaplasmic,' substances is exceedingly difficult to define—largely on account of our vague and inconsistent use of terms, for in practice we continually use the word 'living' to denote various degrees of the vital activity. Protoplasm deprived of nuclear matter has lost, wholly or in part, one of the most characteristic vital properties, namely, the power of synthetic metabolism; yet we still speak of it as 'living,' because it may for a long time perform some of the other functions, manifesting irritability and contractility, and showing also definite coördinations of movements (as in the enucleated protozoan); and, in like manner, various

structural elements of the cell may be termed living in a still more restricted sense. In its fullest meaning, however, the word 'living' implies the existence of a group of cooperating factors more complex than those manifested by any one substance or structural element in the cell, and I am, therefore, thoroughly in accord with those who have insisted that life in its full sense is the property of the cell-system as a whole rather than of any one of its separate elements. Nevertheless, we are perhaps justi- in maintaining that the continuous substance is the most constant and active element, and that which forms the fundamental basis of the system, transforming itself into granules, drops, fibrillæ or networks in accordance with varying physiological needs.*

Whether any or all of these elements are 'living' or 'lifeless' depends largely on the sense in which these words are used; and it is well, therefore, to follow the example of Sachs, in substituting for these words, as applied to special structural elements of the cell, the terms 'active' and 'passive,' which properly admit of degrees of comparison. The distinction between 'protoplasmic' (active) and 'metaplasmic' or 'paraplasmic' (passive) elements, though a real and necessary one, thus becomes, after all, one of degree only.

We are thus brought to consider another point of some interest suggested by the comparative study of the facts described above. Bütschli states that in the true or finer alveolar structure, characteristic of protoplasm in general, the alveoli do not measure more than 2.0 microns, and as a rule are considerably smaller. This, he insists, is not to be confounded with a 'coarser vacuolization,' characterized by larger drops or spheres, which may secondarily arise in the finer structure. Again, Reinke and Waldeyer, in a somewhat similar manner, characterize as 'pseudo-alveolar' a structure arising secondarily through the deposit of passive metaplasmic products of metabolism, such as yolk-spheres, fat-drops and the like, in the living protoplasmic basis. Both distinctions break down, I think, in the light of the foregoing facts. In most of the forms considered—*Arbacia*, *Toxopneustes*, *Echinarachnius*, *Asterias*—the alveolar spheres are considerably less than 2.0 microns (1.0 to 1.7), and the structure is, therefore, a true alveolar one in Bütschli's sense; indeed, Bütschli himself describes and figures the protoplasm of the *Sphærechinus* egg as an example of that structure. In *Ophiura*, however, the spheres measure up to 3.0 to 4.0 microns, and are undoubtedly 'yoke-spheres' in the usual sense. It is, however, quite certain, from the ovarian development of these eggs, that they differ from the others only in degree, and that Bütschli's criterion of size gives no satisfactory ground for any real distinction. The alternative is to regard all the forms as pseudo-alveolar, irrespective of the size of the alveolar spheres, which are in all cases to be regarded as metaplasmic bodies; and this is the view which Reinke specifically applies to *Sphærechinus*. But if this view be adopted we seek in vain for any ground of distinction between such a fine 'pseudo-alveolar' structure as that of *Arbacia* and the 'true' alveolar structure of tissue cells, and are forced to the conclusion that in the latter case also the alveolar substance consists of passive or metaplasmic material —a view which has, in fact, been adopted by some writers. For my part, I am convinced that the entire distinction is without adequate basis, and that no definite boundary-line can be drawn between even the

* It is hardly necessary to state that this view is not original, except in so far as it has been directly suggested by the observations described above; for it has been more or less definitely maintained by many others, and I am only expressing what seems to be a growing opinion among workers in this field.

largest deutoplasm-spheres, vacuoles or other metaplasmic deposits, the alveolar spheres of *Arbacia* or *Toxopneustes* and those occurring in tissue-cells; and probably all are, in the sense indicated above, to be classed among the relatively passive or metaplasmic material.

How generally the alveolar, reticular or fibrillar formations may occur is a matter still to be determined by observation. It is probable that the alveolar structure will be found to be of more general occurrence than has been supposed; and, judging by the appearance observed in echinoderm and other eggs, and in coagulated albumen and other structureless proteids, I suspect that some cases of so-called 'reticular' formations will be found to arise through the more or less imperfect fixation of the alveolar, leading to the coagulation, contraction and breaking down of the alveolar walls,* though I do not for a moment mean to imply that such is the case with all reticula.

What light, if any, do the foregoing general conclusions throw on the theoretical views outlined at the beginning of this lecture? The answer must be: None that is clear and satisfactory, for the background of all the phenomena appears to lie in the invisible organization of a substance which seems to the eye homogeneous. Yet there is, I think, much in these conclusions to suggest, and nothing to contradict, the hypothesis that the 'homogeneous' or 'continuous' substance may be composed of ultramicroscopical bodies, by the growth and differentiation of which the visible elements arise, and which differ among themselves chemically and otherwise, as is the case with the larger masses to which they give rise. I will not enter upon a discussion of the question whether these bodies are merely molecules, more or less complex, or groups of molecules forming protoplasmic units or micellæ, but will only make three suggestions: First, if such units exist, they cannot be identified with the visible granules or 'bioblasts' of Altmann, but are bodies far smaller. Second, if there be any truth in what has been said above regarding the localization of 'living' matter in the cell, such protoplasmic units, if they exist, cannot properly be called 'biophores,' since life is a manifestation of the system which they form, and not of the individual units. The corpuscular, or micellar theory of protoplasm, as an hypothesis of morphological organization, should not be confounded with the physiological theory that biophores or pangens are 'elementary living units.' Third, by ascribing to these hypothetical units the power of growth and division, in accordance with the pangen theory, we are enabled to get a certain amount of light upon some of the most puzzling questions of cytology, such, for example, as the ultimate nature and origin of dividing cell-organs like the nucleus or the plastids, and especially such a contradiction as that presented by the centrosome, which may apparently arise either *de novo* or by division of a preëxisting body of the same kind. As De Vries and Wiesner have so suggestively urged, the power of division on which the law of genetic continuity rests and which is manifested by morphological aggregates of so many different degrees, may have its root in a like power of the primary units at the bottom of the series, out of which all the higher members are built. But while giving due weight to this suggestive hypothesis, we may question whether its acceptance does not introduce as many new special difficulties as those which it sets aside; while we must admit that it leaves untouched the fundamental problem of division. The solution of this problem may perhaps have to be sought in

* It may be well to point out that Rhumbler has produced true fibrillar and reticular formations in coagulated artificial gelatine-emulsions.

a quite different direction from the pangen hypothesis. Whether we shall succeed in finding it is another question.

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PICTURES IN THREE DIMENSIONS.

A CHICAGO publishing firm has put on the market a series of pictures in which a stereoscopic effect is produced by a device which seems not to have been used before in this country, but which is well known in Germany. Two photographs of an object are taken at distances apart equal to the distance between the eyes, and with objectives whose focal lengths are equal to the distance of distinct vision—that is, in the ordinary manner of making stereoscopic pictures. These two pictures are printed in two different colors, say red and green, so as to nearly but not quite overlap each other, and they are then looked at through spectacles composed of red and green glass. If the red picture is to the right and the green picture to the left, then the right eye looks through a green glass and sees in strong *black* the picture which is printed in red, but overlooks the faint green picture by the side of it; at the same time the left eye looks through a red glass and sees in sharp black outlines the picture which is printed in green, but not the faint red shadow at the side of it. In this way are produced the two halves of a stereoscopic impression, and a very good illusion of relief is obtained.

That the explanation above given is the correct one is proved by the fact that the images of near objects are plainly farther apart than those of distant ones; that if one looks attentively, with the glasses on, one can see the shadowy secondary pictures at the right and left of the principal one; that by putting on the spectacles wrong side up an inversion of the relief is obtained—near objects look far and far objects look near, so far as this is not interfered with by other elements of solid vision, as perspective, shadows, overlapping, etc., and that, by inverting the picture as well as the spectacles, the correct relief is again obtained; and, finally, by the fact that when one sees single an object in the foreground, one is evidently not fixating upon the plain of the paper, because the title of the picture, in plain black lettering below, is then perceived to be doubled.

The pictures of this issue are roughly made, and while the illusion is very strong it is not at all perfect; the distance between a child in the foreground and a building in the background will be, for instance, very distinct, but the child will be itself rather flat. With better workmanship, this method for securing vision in the third dimension ought to have an important future. The stereoscope has, for some reason, never lent itself to the purposes of art; this process, which has much less paraphernalia, and hence has its mechanicalness much less in evidence, may conceivably fill a more important rôle in this respect. However that may be, its usefulness for scientific purposes ought to be very great. There are countless intricate things which one desires extremely to represent in their solidity, and which it is unnecessarily hard for the reader to catch the bearing of when they can only be seen in the flat. Think for a moment how great would be the difficulties of the student of geometry if he had no more lifelike representations of his plane triangles than he has of his polyhedra and his parallelopipedons, and then imagine the pleasures that are in store for him if he has only to pick up his red and green spectacles to see the figures of solid geometry in all the reality which has hitherto existed for him only in the plane! And what rapid progress will be made in the imaginings of the stereo-chemist when he is given this ma-

terial aid to the construction of his right-handed and left-handed molecules! It is strange that more use has not been made of the ordinary stereoscope for purposes of scientific illustration; instead of having expensive models of the forms of higher mathematics, every purpose would be subserved if a set of stereoscopic views of them were provided. With this new and more simple device there is every reason to hope that representation in the solid, requiring merely that a person should take his red and green glasses out of his pocket, will become nearly as much a matter of course as plain, or rather plane, diagrams are now.

Another field for the application of this principle is in illustrations thrown on the screen for large audiences. There would be no difficulty whatever in projecting one picture of a stereoscopic pair through a red glass on to the screen, and the other through a green glass, and providing the onlookers with the corresponding spectacles; this, in fact, is the special form of the process which is already in use in other countries. For this form, as well as that on a card for individual use, stereoscopic pictures already made need only to be reproduced in the proper colors to answer the requirements of this new method.

As regards the painter of pictures in the artistic sense, it is perhaps prophetic that he has already furnished his paintings strong purple shadows; he has only to intensify the greens on the *other side* of his trunks of trees, and to provide the necessary green and purple glasses for his critics, in order to show them a picture of reality, such as he has before only dreamed of producing.

The process ought, therefore, to have an important future. The present publisher in the Redheffer Art Publishing Co., Baltimore Building, Chicago.

C. Ladd Franklin.

THE INTERNATIONAL CATALOGUE OF SCIENTIFIC LITERATURE.

BOTANY.

It is manifestly quite impossible to-day to make a satisfactory schedule of the classification of botanical books and papers for use in libraries, since, to be satisfactory to the botanists, it should represent the present development of the science, while, on the other hand, such a representation would be far beyond the technical botanical knowledge of the librarians. It is the misfortune of Science that much of its administration must be entrusted to persons who have, at the best, only a general knowledge of the subject, and this very often representing an old phase of the science, long since abandoned in the laboratory and lecture-room. It is, perhaps, impossible to have it otherwise, at least for a long time to come; we cannot require librarians to know as much in regard to the progress of Science as the workers themselves. It is inevitable, therefore, that any scheme of the classification of botanical books which can be used by librarians must fall considerably short of representing the present condition of the science. On the other hand, as revisions of library schemes are made from time to time, it is desirable that the classification should be brought forward somewhat nearer the present condition of Science, as far, at least, as can be done with safety, since no library, by its inertia, should become, to a marked degree, the conservator of abandoned scientific views.

The International Catalogue Committee apparently have kept in mind something like the foregoing, and have wrought out a scheme which will no doubt be workable by librarians and those whose knowledge of Botany is general rather than specific. Probably few, if any, objections will be brought against it by the librarians and general students of plants, at least in so far as the general plan is concerned. We may,

however, look for objections from the specialists whose work has carried them far beyond the somewhat old-fashioned grouping of subjects here adopted, and it becomes our duty to inquire whether or not it is advisable at this time to still further modernize the classification proposed.

The primary divisions made by the committee are as follows:

I.—Bibliography (including philosophy, history, biography, dictionaries, text-books, pedagogy, addresses, lectures, essays and works on method.

II.—External Morphology and Organogeny (including this consideration of the vegetative and reproductive organs, alternation of generations, and teratology).

III.—Anatomy, Development and Cytology (including this consideration of the vegetative and reproductive organs, embryology, anatomy and development of tissues and cytology).

IV.—Physiology (including the physiology of (*a*) the vegetative organs and (*b*) the physiology of reproduction).

V.—Pathology (including diseases due to malnutrition, to other plants, to animals, to other or unknown causes, wounds, reparative processes, galls, treatment of diseases).

VI.—Evolution (including heredity, variation, natural and artificial selection, degeneration, phylogeny).

VII.—Taxonomy (including general works on systematic botany, nomenclature, etc., and those relating to plants falling under any of the great plant groups from Dicotyledons down to Bacteria and Mycetozoa).

VIII.—Geographic Distribution (including general works, local floras grouped by countries, and plankton botany grouped into temperature zones).

When we attentively consider the foregoing we note that:

1. The first division is made to include much more than bibliography; in fact, one may well wonder why Philosophy is included here rather than under Evolution; why Text-books are not entered in one or more places under the 'General Works,' for which provision is made in each division; and why Lectures and Essays should not be similarly distributed according to the subjects of which they treat.

2. The use of 'Anatomy' in the sense of Histology in the third division will lead to confusion. Anatomy as generally understood refers to the gross structure, as contrasted with minute structure, with which Histology concerns itself, and since the treatment in the third division is evidently intended to be histological it will be better to use the more appropriate term—Histology.

3. In practice there will be much confusion between Taxonomy and Geographic Distribution. The latter, in spite of its name, appears not to include what we now call Phytogeography or Geophytography; on the contrary, it is rather the geographic distribution of the books and papers; thus Gray's Manual would appear under the subhead 'North America,' while Hooker's Student's Flora would appear under 'Europe,' etc. One is puzzled to know what to do with Ellis and Everhart's 'North American Pyrenomycetes' under this scheme; is it to be put under Taxonomy, or under Geographic Distribution, with other North American floras?

4. In regard to minor matters one is compelled to object to the treatment of the reproductive organs. Under 'External Morphology and Organogeny' we have the following titles, viz.: Reproductive Organs, Flower and Inflorescence, Fruit, Seed, Sporangia, Vegetative Organs of Propagation, and under 'Anatomy, Development, and Cytology' we find these heads, viz., Reproductive Organs, Flower and Inflorescence, Perianth, Androecium, Gynœcium, Fruit, Seed, Sporangia (Cryptogamic), Sexual Organs (Cryptogamic), Vegetative Organs of Propagation. With such a schedule what can we do with papers treating of the prothallia of Pteridophyta, the uredospores of the Uredineæ, or the bosidiospores of the mushrooms and puff-balls? The trouble here is that the schedule is either not full enough of particulars or too full in certain lines, thus emphasizing the want of particularity in others.

5. The insertion of Botanical Gardens, Museums and Herbaria in the division 'Taxonomy' is, to say the least, quite unexpected. Why we should regard these illustrative collections of plants as taxonomic is impossible to make out. These constitute and are as much a part of Morphology, Anatomy, Physiology, Pathology and Geographic Distribution as they are of Taxonomy. They should be given separate place or be introduced under each of the foregoing heads.

As we run over the schedule prepared by the International Committee we cannot help wishing that they had had access to the as-yet-unpublished address by Dr. Wm. Trelease on 'The Classification of a Botanical Library' given before the Botanical Seminar of the University of Nebraska in May, 1898, embodying the results of years of study of the problem. This is not the place in which to discuss Dr. Trelease's classification, especially since it has not yet appeared in print, but it may not be out of place to call the attention of the International Committee to it, as we understand that it is to appear within a few months.

It is evident that we must look to some one like Dr. Trelease for the solution of the problem. The librarians cannot solve it, nor can the botanists themselves; the former know too little of botany, and the latter know too little about library technique. We must look to the men who are modern, working botanists, and who at the same time have charge of large botanical libraries, as they alone are able to see the botanical needs, on the one hand, and the library limitations, on the other.

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ANTHROPOLOGY.

The International Catalogue Committee naturally encountered special difficulties in dealing with the subject of anthropology, for the reason that this youngest of the sciences is not yet organized in a manner acceptable to the entire body of students. It is doubtless for this reason (at least in considerable measure) that the scheme proposed is not classific in any proper sense, but rather a nearly random assortment of catchwords of two degrees of magnitude. Thus, while the first major division, 'Museums and Collections,' is a fairly logical and convenient one, and its subdivisions are clearly defined and acceptable, the other major and minor divisions form a curious medley. The remaining major divisions are 'Archæology,' 'Anthropometry,' 'Races,' 'Industrial Occupations and Appliances,' 'Arts of Pleasure,' 'Communication of Ideas,' 'Science (chiefly of primitive races),' 'Superstition, Religion, Customs,' 'Administration' and 'Sociology (chiefly of primitive races).' The first of these divisions is based on individual objects defined by a time limitation; the second is based on laboratory procedure and apparatus; the third has a material objective basis, but the units are collective and not all individual; the fourth and fifth divisions are based on activities and not on objects, and there is an implied time limitation growing out of the separate arrangement under 'Archæology;' while the remaining divisions are partly objective yet chiefly activital, partly individual yet chiefly collective in basis. The heterogeneity in the divisions, both primary and secondary, suggests studied avoidance of attempt to classify the Science of Man in any comprehensive way.

By reason of the diversity in basis, considerable overlapping of even the major divisions is occasioned; *e. g.*, 'Archæology' overlaps the fourth and fifth divisions in a manner peculiarly inconvenient to students who interpret prehistoric artifacts through study of the handicraft of living savages and barbarians, while 'Administration' and 'Sociology' mean so nearly the

same thing that these divisions practically overlap throughout. For the same reason, certain divisions are unduly restricted; *e. g.*, 'Customs' is used in a narrow sense, while the term is commonly extended over nearly the whole range of the human activities. Perhaps for a similar reason, there are serious lacunæ in the scheme; 'Prehistoric human remains' (a subdivision of "Archæology') and several subdivisions of 'Anthropometry' have place, yet there is no place in the scheme for the important subject of somatology; so also 'Superstition' and primitive 'Science' (whatever that may mean) receive ample space, while there is no philosophy (or mythology), which constitutes a leading subject of anthropologic inquiry. Possibly somatology and philosophy are relegated to other primary categories not included in Anthropology; but, if so, the confusion in the mind of the anthropologist desiring to use the catalogue will be only the greater. On passing to the subdivisions, both the overlapping and the lacunæ become still more conspicuous; indeed, the instances are too many for citation without practically rewriting the list.

It is only fair to ascribe much of the chaotic character of the scheme to the ill-organized state of the science; yet no extension of fairness can conceal the conspicuous fact that the scheme *is* chaotic, and to such an extent as to incommode seriously the anthropologist who may seek to apply it.

The applicability of the scheme may easily be tested by an example or two. Suppose Dr. Boas' rather special memoir on 'The Social Organization and the Secret Societies of the Kwakiutl Indians' be selected, and suppose it be catalogued by actual content: In the first place, it is based primarily on collections in the National Museum, and its illustrations are largely representations of Museum specimens indicated by Museum numbers, which would place it in the first major division of the scheme, with the subdivision number 0030. Then some of the objects and traditions described are essentially prehistoric, so that it would seem to require entry under the second major division, perhaps in number 0650; while there is sufficient reference to racial characteristics to suggest entry under the fourth division, say in number 1950. Certainly, too, the work would have to be entered in each of the next three major divisions, probably under numbers 2000, 2050, 2370, 2400, 2500, 2510, 2520, 2600, 2700, 3000, 3050, 3100, 3400, 3550, 3600 and 4100; while it would also find necessary place under each of the remaining major divisions, and in at least a dozen more numbers. All this for a single moderately special memoir! Another example, taken at random, is Dr. Carus' recent pamphlet on 'Chinese Philosophy,' a memoir of special scope and of particular significance to museum workers as well as to general anthropologists. In the absence of an appropriate general division, it would require introduction probably under 'Arts of Pleasure,' and certainly under 'Communication of Ideas,' 'Science,' and 'Superstition, Religion, Customs,' and ought to be entered under 3100, 3550, 3600, 4100, 5100, 5400, 5500, and possibly three or four other numbers. These examples suffice to illustrate the difficulties in the way of cataloguing anthropologic literature under the scheme proposed; indeed, it would be a wise anthropologist who could, without burdensome repetition, catalogue under the scheme any considerable mass of literature, even for his own use, in such manner as to give him much aid in scanning the literature a few years later; while the uncertainty of cataloguing for others, or of depending on the cataloguing of others, would seem to outweigh any advantage attending the proposed schematic arrangement. The difficulties of cataloguing would naturally be greatly diminished if the cataloguer con-

fined attention to the titles; but they would not disappear, as the examples show, while the value of the catalogue would be greatly reduced. Of course, the difficulties are due largely to the unorganized condition of the science; yet it does seem practically certain that any single anthropologist, well abreast of the science and working constructively, might have evolved a homogeneous and consistent scheme, by which anthropologic cataloguing would be facilitated rather than burdened.

Inspection of the scheme raises the question whether it is designed primarily for the use of librarians, or for the convenience of scientific workers; and the arbitrary features at once suggest that the users contemplated cannot be investigators, of whom the great majority are accustomed to methods of gaining and maintaining acquaintance with scientific literature quite unlike those embodied in the scheme. These usage-honored methods are epitomized in the systematic lists of contents and (more especially) the indexes with which respectable scientific books are provided. Now the character of current indexes of anthropologic books (particularly those prepared by authors themselves) indicates that the ideas of investigators are crystallized about certain nuclei, which are essentially denotive—names of men, names of books, names of races or nations or tribes, names of places, etc.; there is relatively slight attempt, so far as the indexes show, to crystallize ideas about necessarily vague connotive nuclei. It is true that the typical list of contents is much more largely connotive than the typical index; but even here there is a strong tendency toward arrangement in terms of trenchant concepts, *i. e.*, in denotive terms. What is true of anthropologic literature is measurably true of the literature of other branches of science, though most or all of the other branches are so well organized as to yield larger series of specific terms habitually used in denotive sense. The scientific makers and users of indexes are concerned with the essentials of scientific literature, rather than with the mere externals which appeal to the librarian *per se;* and the weakness of the scheme herein noted would seem to lie in the fact that it gives no promise of guiding or aiding the investigator in any useful way, howsoever convenient it may be as a guide to book-handlers concerned only with the external aspects of anthropologic publications.

The final test of the value of any catalogue is found in the practical operation of the law of supply and demand, with respect to both raw material and finished product. As bearing on this test, it may be observed that no working anthropologist in the Bureau of American Ethnology would seriously undertake the cataloguing of anthropologic literature, or any branch thereof, in accordance with the extravagantly complex scheme of the Royal Society Committee, and that the library of the Bureau could not be arranged under it; also that, while the office would probably subscribe for author cards and the lustral book-catalogue, the subscription for the latter would be made much more freely if it were a simple author list. And the arbitrary symbols on cards and pages would be regarded merely as trivial blemishes, unsightly but not necessarily mischievous.

W J McGee.

THE ROYAL SOCIETY OF CANADA.

The eighteenth annual meeting of the Royal Society of Canada was held at Ottawa from May 22d to 26th. Fellows from the provinces of Nova Scotia, New Brunswick, Quebec, Ontario and British Columbia were present. The Council met in the office of Sir John Bourinot, House of Commons on Monday, and Tuesday morning the regular work of the Sections began. The readers of Science will recall to mind that

this Canadian Society is divided into *four* sections, viz.: Section I., French poetry, literature, history, etc.; Section II., English literature, history, poetry, etc.; Section III., Mathematical, physical and chemical sciences; Section IV., Geological and biological sciences. Among the more interesting papers read before this Society, in the field of letters and science, the following are noticed: 'First Three Years in Acadia under the English Régime,' by P. Gaudet; 'Responsible Government under Lord Sydenham,' by Hon. Jos. Royal; 'Quebec in 1730,' by Abbé Gosselin; 'Literary Development in Canada,' by Hon. J. W. Longley, Attorney General of Nova Scotia; 'The Builders of Nova Scotia,' by Sir John Bourinot; 'Migration from the Canary Islands to the Eastern Coast of America,' by John Campbell, LL.D. This paper indicates the presence of extensive Celtic and Basque elements in the languages of Peru, and traces these to the Canary Islands, where history finds Celtic colonists, and recently discovered inscriptions, presented in the paper, reveal the existence of petty Iberic kingdoms alongside of them. The Celts came from the Berber area of northwestern Africa, and the Iberians from Spain. As the Toltecs and Olmecs, these Iberic and Celtic colonists from the Canaries entered Mexico in the beginning of the eighth century A.D., and when expelled, in the middle of the eleventh century, they founded the Peruvian Empire of the Incas, but tradition indicates that a portion of the Celtic crews from the Canaries landed in Florida, and that their descendants, after the time of European colonization, became known as Welsh Indians. Linguistic enquiries tend to trace the survivors of these to Arizona and California in the west, and to the almost extinct Adaizans of Louisiana in the east.

'Hochelagans and Mohawks, a Link in Iroquois History,' by W. D. Lighthall, M. A.; 'The Valley of the Ottawa, 1650–1700,' by Benjamin Sulte.

'Historic Places and Events in New Brunswick,' by Professor W. F. Ganong, Ph.D., M.A.; 'The Distinctive Characteristics of the Japanese and Chinese People,' by Professor E. Hamilton Sharp (of Tokio University).

'The Synchronism of Terrestrial Magnetic Disturbances and Unusual Excitation in the Trails of Comets,' by Arthur Harvey; 'Illustrations of Remarkable Secondary Tidal Undulations on January 1, 1899,' by W. Bell Dawson; 'Canadian Geological Nomenclature,' by Dr. R. W. Ells, President of Section IV.; Studies on Cambrian Faunas No. 3, ditto No. 4, including the 'Upper Cambrian Fauna of Mt. Stephen, British Columbia,' and 'Fragments of the Cambrian Faunas of Newfoundland,' and by the same author 'The Etcheminian Fauna of Smith's Sound, Newfoundland,' all by Dr. G. F. Matthew. The Mt. Stephen fossils are remarkable for their excellent mode of preservation. The author correlates the genera with European forms of Upper Cambrian age. New fossils from Newfoundland are described and recorded, others redescribed. The zoological position of the Hyolithidæ is discussed, and the author concludes that they should be classed with the Tubicolous Worms. Figures and descriptions will accompany these papers.

'Notes on some additions to the Molluscan Fauna of the Pacific Coast of Canada,' by Rev. G. W. Taylor, M. A., of Nanaimo, B. C. The author gives notes on *forty* species not hitherto recognized.

'Origin and History of some new varieties of Wheat produced at the Dominion Experimental Farms,' by Dr. William Saunders, Director. The most promising crossbred varieties of wheat produced during the last ten years at the Experimental Farms of Canada are discussed at length. Re-

markable success was obtained in the experiments. Particulars are also given as to how these varieties compare with the *standard* sorts in cultivation and notes on their adaptability to the different climates of Canada.

'The Scientific Work of Professor Charles F. Hartt,' by Professor G. U. Hay, M.A., Ph.B. A tribute to one of Canada's most illustrious sons who laboured successfully in the field of Geological Science, first in Canada, then in Cambridge and later in Brazil, where he fell a victim to yellow fever, in 1878, at Rio Janeiro, where he held the post of Director of the Geological Commission.

'Recent additions to the Injurious Insects of Canada,' by Dr. James Fletcher, F.L.S., etc. This paper treats of the several injurious species which have attracted public attention by their ravages upon crops of all kinds for the last twenty years. It will form a most practical as well as scientific treatise on a subject of vital importance to Canada.

'Catalogue of Canadian Proctotrypidæ,' by W. Hague Harrington, Esq. Two hundred species are enumerated, most of which come from Ottawa and its vicinity. Descriptions of new species are given and notes on the habits of several species added.

'On the Origin of the Silvery Appearance in the Integument of Fishes,' by Professor E. E. Prince, B.A., F.L.S., and 'Some Chitinous Elements in the Larval Skeleton of Fishes which appear to be Primitive,' by Professor E. E. Prince, also form two interesting contributions to the science of biology.

'The Geology of the more important Cities in Eastern Canada' is the title of a paper by Dr. H. M. Ami. Geological tables have been drawn up for St. John (New Brunswick), Quebec City, Montreal, Ottawa, Kingston, Toronto, Hamilton and London.

Professor T. Wesley Mills, of McGill University, entertained Section IV. with an intensely fascinating subject, 'An Investigation of the Physiology of the Brain of the Bird,' together with 'An Examination of some points in the Psychology of that Animal.' Two pigeons whose brains had been almost entirely removed and wounds healed have been subjected to close examination and their behavior noted. Upwards of four months have elapsed since the operation was performed, and Dr. Mills awaits further developments before submitting the healed parts to a microscopical examination.

On the evening of the 23d of May—an evening with our Canadian poets and writers was held with immense success. Dr. W. H. Drummond, of Montreal; Wilfred W. Campbell, of Ottawa; W. A. Frazer, of Toronto; W. J. Phillip-Woolley, of British Columbia; Attorney-General Longley, of Halifax, Nova Scotia; Duncan C. Scott, of Ottawa; Dr. Louis Frèchette, Laureate of the *Académie de France*, of Montreal, and Revs. Frederick G. Scott, of Drummondville, Quebec, and Archbishop O'Brien, of Halifax, took part.

At the public meeting Professor Rutherford, assisted by Professor John Cox, of the Physics Laboratories, McGill University, described and illustrated 'Wireless Telegraphy' to a large audience with marked success.

H. M. Ami.

Ottawa, June, 1899.

SCIENTIFIC BOOKS.

The Anatomy of the Central Nervous System of Man and of Vertebrates in General. By Professor Ludwig Edinger, M. D. Translated from the Fifth German Edition by Winfield S. Hall, Ph.D., M. D., assisted by P. L. Holland, M.D., and E. P. Carlton, B.S. The F. A. Davis Co. Pp. 446. Figs. 258.

Few books could be more welcome in an acceptable English dress than the last edition of Edinger's 'Vorlesungen ueber den Bau der Ner-

vösen Centralorgane,' the greatly enlarged fifth edition of which has been for some time in our hands and has quite superseded the translation by Dr. Riggs, though the latter has already served a useful purpose in introducing our author to the American public. The transformation which this book, intended simply to give a summary of the best-established facts of neurology for busy people, has undergone in so short a time is a good index of the progress the science has been making.

Professor Edinger quotes with approbation the suggestion of Burdach that, in addition to the gathering of building material, every period brings with it the obligation to attempt anew the rearing of a structure presenting the knowledge in definite form. This synthesis of our present knowledge Edinger endeavors to give. In some parts of the edifice, it is true, the efforts result chiefly in making more evident great gaps to be filled. This is for the active investigator a most important service in itself, especially when brought into relation with the received facts in such a way as to afford a perspective of the path which research may profitably follow.

No one now-a-days could fail to appreciate that the light needed for the decipherment of the intricate structure of the human brain must come from the study of the simpler brains of lower vertebrates, and no one has had better opportunities than Professor Edinger to supply just this light. Not only have his own studies peculiarly fitted him for this work, which his experience as practical physician and teacher has tended to keep in touch with human interest, but the duty of preparing a yearly summary for Schmidt's *Jährbucher* has enforced the necessity of a minute knowledge of the work done in these lines by others the world over. More than any other leading European neurologist he has familiarized himself with the work of his contemporaries in all lands.

The book as it now stands contains, in addition to the material of the original twelve lectures on the structure of the mammalian brain which now constitutes Part III., an introduction devoted to fundamental conceptions and physiology of brain and peripheral nerves, and Part II., a review of the embryology and comparative anatomy of the vertebrate brain. It may be admitted that this method of treatment is at the expense of unity and entails some repetition, yet the practical advantage to the student who may be chiefly interested in human anatomy is manifest.

The results of the author's studies of the forebrain and mid-brain of reptiles are here used to great advantage. It has been a matter of surprise to the present reviewer that the desirability of starting with the reptilian brain has not been more clearly recognized by teachers of the comparative anatomy of the brain, for in this group we have a degree of simplicity without the puzzling interference of the specialized structures found in the brain of fishes or the embryonic lack of differentiation seen in amphibia. The present book makes this course possible and presents the strongest possible reasons for pursuing it.

As might have been expected, the olfactory apparatus is clearly and fully treated, as are the cephalic parts of the brain in general.

The discussion of the cerebellum, on the other hand, is somewhat less satisfactory than the other sections, and serves very vividly to enforce the need of thorough comparative work on this organ in spite of the wealth of isolated facts recently accumulated. "Of the connections and definite course of the fibers of the cerebellum there is, as yet, little known." "Where the inferior cerebellar peduncle enters the cerebellum is the least understood portion of the whole nervous system." "Least known as to their real origin are several frontal tracts." "The relation of the nuclei to the fiber system of the white substance is almost wholly unknown." In fact, it has to be admitted that we have but the vaguest idea of the relations of the afferent, efferent and special sensory fibers that have been traced into or to the cerebellum. The present writer may remark that his suggestion, made several years ago on the basis of a study of types from nearly all groups of vertebrates, that connections are established, by way of certain 'switch cells' in the pes pedunculi, between descending motor tracts from the cerebrum and fibers to the cerebellum, has remained unchallenged, and offers a reasonable basis for interpreting some of the facts of phys-

iology. It is not correct to say with our author that the cerebellum is ontogenetically developed from a simple cell plate. There is abundant evidence that the cerebellum is essentially a paired organ, and this, too, is in harmony with its function. The curious method of supplying its surface where the bulk is increased, as in mammals, by lateral diverticles deserves passing mention.

The English translation is neatly printed, though there are a few mistakes which greater care would have avoided. Figure 3, for example, is wrong side up, and thus the description is belied.

The translation is far from faultless, though for the most part intelligible. We are prepared to find that a translator should be so influenced by the idiom of the original as to produce a somewhat halting English style, and it often happens that the translator's own style leaves something to be desired, but there is no excuse for translating Gehörgrube as oral pit, as Dr. Hall has done. Fasersystem appears as 'tract' in a connection where it is important to distinguish between these terms. 'Dicht anlegen' is translated 'lie close beside.'

On page 16 the author is made to say 'all vertebrates,' where the original says 'all lower vertebrates,' and proceeds to make an important distinction between lower and higher vertebrates.

We do not wish to enter upon the field of vexed neuronomy, but regret that the translator was not satisfied with 'neurite' or 'axis cyclinder,' as used by the author, and substitutes the less satisfactory 'neuraxon,' which Dr. Edinger did not use at all. 'Fundament' for 'Anlage' is to us an unpleasant word, to say nothing of its ambiguous sound. 'Proton' is sufficiently well known. It seems strange that in an English work we should need to puzzle over the terms of direction 'up and down,' 'back and forward,' etc. Minor inaccuracies like 'mantel' for 'mantle' in one place are probably slips in proof-reading.

On the whole, then, while we congratulate ourselves on this addition to the resources of the teacher of neurology, we hope that a later edition may remove these causes for irritation to the instructed reader. C. L. Herrick.

The Characters of Crystals, an Introduction to Physical Crystallography. By Alfred J. Moses, E.M., Ph.D., Professor of Mineralogy, Columbia University, New York City. New York, D. Van Nostrand Company. 1899. Pp. 211.

This little volume contains the principles of modern crystallography and descriptions of the instruments and methods used in the determination of the various physical characters of crystals. The advanced student in mineralogy and crystallography will find it of much assistance, because it presents in a concise form, omitting unnecessary detail, the subjects treated of in the larger foreign text-books on physical crystallography.

The contents are divided into three parts, the first dealing with the geometrical characters of crystals. In the classification of the thirty-two types of crystals the author has followed Professor Groth, and has wisely retained the same descriptive names for the classes and forms. The common methods of measuring crystals are well described, but a more complete description of the use of the two-circle goniometer would have been better, since this instrument will undoubtedly be used in the future by the advanced worker more than the ordinary goniometer; also in the chapter on crystal projection no mention is made of the gnomonic projection, the value of which Professor Goldschmidt has so well demonstrated. This projection possesses so many advantages over Miller's that it, in connection with the use of the two-circle goniometer, should be understood by every mineralogist.

An excellent course in optical crystallography is given in the second part of the book. The causes of the various optical phenomena and the latest methods for the determination of the optical characters of crystals are explained briefly, yet clearly enough for the student to readily understand this difficult subject.

The third part treats of the general physical characters, such as the effects of heat, magnetism, electricity, etc., on crystals. The author appends a synopsis of an advanced course of crystallography as given at Columbia University. The book is well illustrated by crystal-drawings and by cuts of instruments, and fre-

quent references to original articles are cited in the foot-margins.

This is the first American text-book on purely physical crystallography, and, containing, as it does, the sum of what is at present known on the subject, it must commend itself to every student of the science.

A. S. EAKLE.

HARVARD UNIVERSITY.

Algebra for Schools. By GEORGE W. EVANS, Instructor in Mathematics in the English High School, Boston, Mass. New York, Henry Holt & Co. 1899.

This book is a fresh treatment of the topics commonly found in algebras for schools. It is by no means a mere compilation or reprint with slight alteration of texts now before the public. While, of course, it is not, nor pretends to be a contribution to knowledge, it is distinctly what the author has sought to make it, a real contribution to the art of presenting knowledge to the beginner. Ordinary algebra is, in its elements at least, nothing but an extension and refinement of common sense applied to number. Consistently with this idea, the author's arrangement of topics, as well as his method of attack —in both of which respects there is a noticeable departure from tradition—are well adapted 'to preserve the pupil from the besetting sin of conceiving algebraic operations as a species of legerdemain.' An appeal is invariably made, in the first instance, to the reader's practical sense. Theory is not slighted; being approached through concrete examples, it is, however, rather produced than presented, and its correctness is not so much demonstrated as its *reasonableness* is shown. As instances of this procedure may be cited the treatment of signs, imaginaries and exponents. In case of the latter two themes the spirit is particularly commendable. Among other specially praiseworthy features are the chapter on the abbreviation of rules by means of symbols; the prominence given to identities, together with the clear distinction between the latter and equations of condition; the geometric interpretation of the simplest equations; the extended and accentuated treatment of factoring and of the quadratic equation; the discussion of the notions of constant, variable and limit, and the abundance and variety of exercises not copied from other works. An easily detectable slip in logic occurs on p. 105 in justifying steps (4) and (6) by reference to axiom *A*. The proper justification is that such equations are satisfied if either factor be equated to zero.

An adequate characterization of the book is impossible in so short an account. That it is immensely superior to the average of its rivals is obvious on comparison. It should be added that the book is written in excellent English, and is well printed and well bound.

C. J. KEYSER.

COLUMBIA UNIVERSITY.

The Emotion of Joy. By GEORGE VAN NESS DEARBORN, A.M., M.D. New York, The Macmillan Company.

This monograph opens with a rather extended vindication of parallelism, but the writer cannot keep to this point of view, *e. g.* pages 8, 13, 14, 16. But at any rate parallelism at present is metaphysical, exact coincidence of external expression and internal emotion is yet to be shown experimentally, and, as assumption, it is obscurrantist in breaking up the universal causal nexus, which is the basis of science, and putting a bare dualism for rational coordination. Of course the difficulty of experiment seems insurmountable, since the agent can only indicate to us the moment of his emotion by an expression. After outlining the general parallelistic doctrine of emotion, Mr. Dearborn presents some experiments which are so hypothetical as to be only of the slightest value in revealing the opinions of fourteen persons as to how they would feel and act if given sums of money from ten to ten thousand dollars. Much the most interesting and valuable part of this paper is that which reports researches on the effects which pleasantness and unpleasantness have upon the involuntary muscular movements. It is particularly interesting to notice that "the left hand appears much more sensitive to involuntary reaction than the right, and this was to be expected, perhaps, most of the subjects being right-handed and, therefore, with their right hand 'civilized,' so to say, away from the original biological habits of emotional con-

comitance." Of course this is a wider field than mere joy as specific emotion, but inclusive of it. It may be surmised that the expansive movement for the pleasant and contrary for painful stimulus—which is reinforced by these experiments—is simplest biological reaction concerned with appropriation and rejection in feeding by primitive organisms. However, joy as specific emotion is later and must be studied more introspectively in its functional activity than Mr. Dearborn has done. In neurasthenia joy does not act, as I recall in my own case, once receiving news which normally would have brought great joy but left me quite listless at the time.

Hiram M. Stanley.

BOOKS RECEIVED.

The Races of Europe, a Sociological Study. William Z. Ripley. New York, D. Appleton & Company. 1899. Pp. xxxii+624.

A Selected Bibliography of the Anthropology and Ethnology of Europe. William Z. Ripley. New York, D. Appleton & Company. 1899. Pp. 160.

Plant Relations. John M. Coulter. New York, D. Appleton & Company. 1899. Pp. 264.

Industrie des matières colorantes azoïques. George F. Jaubert. 1899. Pp. 167.

Transactions of the American Microscopical Society. Edited by the Secretary. Lincoln, Neb., Hunter Printing Co. 1899. Vol. XX. Pp. 369.

Report of the Meteorological Service of Canada for the year ending Dec. 31, 1896. R. F. Stupart, Director. Vol. I., pp. 295; Vol. II., pp. 796.

The Soluble Ferments and Fermentation. J. Reynolds Green. Cambridge, University Press. 1899. Pp. xiii+480. 12s.

SCIENTIFIC JOURNALS AND ARTICLES.

The June number of the *Bulletin of the American Mathematical Society* contains a report of the April meeting of the Society, by the Secretary; 'Surfaces of Revolution in the Theory of Lamé's Products,' by Dr. F. H. Safford; a review of 'Picard's Algebraic Functions of Two Variables,' by Arthur Berry, M.A.; 'Note on Page's Ordinary Differential Equations,' by Dr. L. E. Dickson; a review of 'Tannery's Arithmetic, by Professor James Pierpont; 'Notes,' and 'New Publications.' The July number of the *Bulletin*, which concludes volume 5 of the new series, contains 'The Asymptotic Lines of the Kummer Surface,' by Dr. J. I. Hutchinson; 'On a Definitive Property of the Covariant,' by Mr. C. J. Keyser; 'The Known Finite Simple Groups,' by Professor L. E. Dickson; a review of 'Schoenflies's Geometry of Movement' and of its French translation by Speckel, by Professor F. Morley; a review of the new edition of 'Weber's Algebra,' by Professor James Pierpont; 'Shorter Notices;' 'On Elliptic Functions,' by Professor James Pierpont; 'Notes;' 'New Publications;' annual list of papers read before the Society and subsequently published, and an elaborate index of the volume.

The June number of the *Botanical Gazette* opens with a morphological study of the common May apple, *Podophyllum peltatum*, by Mr. Theo. Holm, illustrated by ten figures drawn from nature by the author. Mr. Holm discusses the mode of germination, the distribution, relation and arrangement of the leaves and buds. Some structural details of the mature plant are also given. The study shows clearly that *Podophyllum* is closely related in its habits and ecological peculiarities to a little natural group of plants: Diphylleia, Jeffersonia, Caulophyllum, Actæa and Cimicifuga. He thinks it better to associate these plants than to separate them by the insignificant floral characters which have been used to put them into separate orders. Capt. John Donnell Smith continues his description of new plants from Guatemala and other Central American republics. Mr. T. S. Brandegee also describes a considerable number of new species of Western plants. Dr. C. O. Townsend discusses the effect of ether upon the germination of seeds and spores. He finds that a weak atmosphere of ether tends to hasten the time of germination, while a larger amount of ether retards or prevents it. Dr. A. P. Anderson figures and describes a new Tilletia parasitic upon the cultivated rice. An appreciative biographical sketch of the late Dr. Alvin Wentworth Chapman is contributed by Dr. Charles Mohr, a long-time friend of Chapman. It is accompanied by a small but excellent portrait of Dr. Chapman. Professor F. A. Waugh discusses the application of the name *Prunus insi-*

titia, concluding that Linnæus meant by it *Prunus domestica Damascena*, while Gray applied it to *Prunus spinosa*, and Walter to *Prunus angustifolia*. Walter H. Evans describes a new branch from Alaska. A fascicle of Book Reviews, Notes for Students, and News complete the number, which is the concluding one of Volume XXVII.

AT the annual meeting of the American Medical Association Dr. George M. Gould, of Philadelphia, proposed that the publication of the *Index Medicus* should be undertaken by the Association. He moved the following resolution, which was referred to the Board of Trustees:

WHEREAS, the suspension of the publication of the *Index Medicus* is a deplorable event, which will result in greatly increased labor on the part of medical men in their literary work, and seriously hindering the progress of medical science, practical as well as literary.

Be it therefore Resolved, That the Executive Committee of the American Medical Association appoint a committee of three members of the Association to take charge of the publication of the periodical, perfect plans for the same and engage the service of an editor and of such editorial assistance as may be required; also to choose a publisher and to make contracts with him for the printing, distribution, etc., of the work all in such manner as to continue the high standards of accuracy and bibliographic usefulness so well established by the previous publishers.

Resolved, That the Treasurer be instructed to pay all bills of such Committee in payment of necessary expenses of such editing and publication, providing that this outlay does not exceed annually $3,000.

DR. H. C. MULLER, of Utrecht, Holland, is preparing to publish an *International Journal of Linguistics*, which is to follow the lines of the *International Zeitscrift für Sprachwissenschaft*, which was discontinued after the death of its editor, Dr. Techmer, of Leipzig.

DISCUSSION AND CORRESPONDENCE.

THE U. S. NAVAL OBSERVATORY.

I HAVE been very much interested in the discussions which have appeared in SCIENCE regarding the Naval Observatory, but, so far as I can learn, certain points have been overlooked which ought to be brought out very plainly.

In the first place, it was really intended by those members of Congress who were influential in having the institution established that it should be devoted chiefly to scientific work. The label of 'Depôt of Charts and Instruments' was added to it, and the plea of utility was employed, because it was feared that the public would not support a scientific institution. For this reason, also, the institution was placed under the Navy Department, since the salaries of the professors and officers engaged in astronomical work would come from the pay of the Navy and would not appear under the Observatory appropriations.

Though a number of eminent men have been in charge of the Naval Observatory, the chief criticism to be made regarding it would seem to me to be the lack of a continuous, well-defined policy. Our Navy has been built up at times and then been allowed to run down, and the line officers have had but little to do. At such times they want control of everything connected with the service, and the scientific work of the Observatory has had to go to the wall. This was the case for some years before the War of the Rebellion, and also about 1882. Of course, a number of the line officers who have been at the Observatory have been able men, who, with time enough given them, could learn anything or do anything. The reason why they did not do well in astronomical work usually was that it took them too far from the profession for which they had been trained.

Logically, I think the Naval Observatory should be placed under scientific management and taken from the Navy, but, as affairs are really managed under our government, with a chance for the methods of the practical politician, I am not so sure. Several years ago an attempt was made to change the organization of the Observatory, and the Naval Committee of the House of Representatives gave a hearing to those interested in the matter. Judging from that hearing, several questions of this kind will have to be answered in the present discussion.

If the work of the Naval Observatory is compared with that of other large observatories in this country, both as to quality and cost, has not the naval management been as good as any other in this country?

Is the present movement being pushed for the benefit of any particular person? This question was asked at the hearing referred to by the Chairman of the Committee.

Are there not already too many detached organizations scattered throughout the departments of the government in such a manner that their business affairs cannot be properly supervised?

This objection might be met by saying that all the scientific work of the government should be brought together under one department, under proper supervision, and with committees in Congress to look after it. Indeed, it seems to me likely that Congress would pass some general measure of this kind rather than take up special legislation for the Observatory alone.

A. Hall, Jr.

Ann Arbor, June 30, 1899.

CEREBRAL LIGHT AGAIN.

In 1897 Dr. Scripture contributed a note to Science (Sci. 6, p. 138, July 23) on what he calls 'cerebral light.' Soon afterward (Sci. 6, p. 257, Aug. 13) I tried to show that whether the phenomena described was of cerebral origin or not the observations of Dr. Scripture did not prove it. I fear Dr. Scripture did not see my criticism.

Now, again, Dr. Scripture brings forward (Sci. 9, p. 850, June 16, 1899) what he thinks demonstrative proof of cerebral origin. Observing the cerebral figures in the early dawn, and looking at the window, he was able to see the figure in the frame of the window. "Now," says he, "placing the fingers of the two hands against the outer ends of the two eyeballs, I displaced them simultaneously in opposite directions. As a result there appeared two images of the frame moving in opposite directions. But the retinal figures seen in front of the frame remained single and *did not move.* Granting that there was no error in my observations, I cannot imagine a more conclusive proof as to the cerebral nature of the light."

Now, I freely grant that there was no error in his observation, yet his conclusion does not follow. In proof of this it is only necessary to make the same experiment with any after-image, say that of the sun. I have just done so. *It behaves in exactly the same way as his cerebral figures.* The reason is obvious. When we press on the sides of the eyeballs external images of *objects* move in the field of view because their retinal images move on the retina. But retinal brands do not move on the retina and, therefore, their spatial representatives do not move in the field of view. I pointed this out in my previous criticism, and this is the reason I think that Professor Scripture did not see it.

As to whether the phenomenon described, or, indeed, any after-image, is retinal or cerebral I have nothing to say. Whether a change in a cerebral cell has its origin in a peripheral impression (retinal), or in the course of an optic fiber, or in the cell itself, it may be difficult to say.

Joseph Le Conte.

Berkeley, Cal., June 28, 1899.

POT-HOLE VS. REMOLINO.

To the Editor of Science: The term 'pot-hole,' so frequently applied, of late, to rounded cavities formed by rivers in their rock-beds, is inelegant and grates harshly on people of sensitive temperament. I suggest, in place of it, the Spanish word *remolino*, which is the common designation in the Republic of Colombia, for phenomena of this order.

Oscar H. Hershey.

Freeport, Ill., June 19, 1899.

ASTRONOMICAL NOTES.

PROPER MOTION.

A valuable contribution to the list of stars with proper motions is made by Professor Porter, Director of the Cincinnati Observatory, in Publication No. 14 of that Observatory. This is in continuation of similar studies previously published, and contains the results of meridian-circle observations of 2,030 stars made between 1893 and 1898, and a careful comparison with earlier observations. A large number of the stars have an appreciable proper motion.

FUNDAMENTAL STAR CATALOGUE.

There has recently been distributed Vol. VIII., Part II., of the publications of the Nautical Almanac Office, which contains Professor

Newcomb's catalogue of 1,596 stars reduced to an absolute system by the methods explained to the Paris Conference in 1896. The Conference authorized the preparation of the catalogue as a provisional fundamental catalogue, and the British and French Almanac Offices assisted in the calculations. The star places are given for 1875 and 1900. The revised catalogue of 383 stars included in the American Ephemeris for 1900 is taken from this fundamental catalogue.

PARALLAX OF THE ANDROMEDA NEBULA.

BULLETIN No. 6 of the Yerkes Observatory records an attempt by Professor Barnard to obtain an appreciable parallax of this nebula from micrometric measurements with the 40-inch refractor. Two small stars were employed and a series was obtained in July and August, 1898, followed by a second series in November and December, 1898. The differences between the two series are no greater than would be expected in such measures, and are contrary in sign to what would be required if the nebula is nearer than the stars.

A HYPERBOLIC COMET ORBIT.

THE number of hyperbolic comet orbits is so small, and their character, generally regarded, as so uncertain, that a genuine addition to the list is heartily welcomed. Mr. Aitken, of the Lick Observatory, has published in the *Astronomische Nachrichten* a definitive determination of the orbit of Comet 1896 III, discovered by Swift. A large number of observations were made at many observatories, which are discussed with great care and impartiality. The weak point in the investigation is that the observations extend over a period of but two months and four days, but the normal places are represented in a highly satisfactory manner by the hyperbolic elements. The residuals are very small in both right ascension and declination and cannot be reduced by any variation in the computed eccentricity.

WINSLOW UPTON.

PROVIDENCE, R. I., July 7, 1899.

RECENT PROGRESS IN THE EXAMINATION OF FOODS AND DRUGS.

IN the modern investigations of foods and drugs it is beginning to be recognized, to some extent at least, that it is the results of the labors of the scientific botanist and chemist which are being utilized, not only by the analyst, but also by the manufacturers of foods and drugs. New medicinal plants are being added from time to time to the materia medica; new food-producing plants are being discovered; the various active and otherwise valuable constituents of foods and drugs are being isolated and investigations made upon them; in short, the plants and their manufactured products are being so extensively investigated that it is quite possible in many cases to distinguish the pure from the spurious, and it would appear that the time is at hand for the framing of national food and drug laws. In the following an attempt is made to indicate some of the recent developments in the examination of foods and drugs.

MEDICINAL PLANTS.

AMONG the new economical plants from East Africa * may be mentioned *Mascarenhasia elastica* K. Schum. (N. O. Apocynaceæ), a tree which yields caoutchouc; *Canarium Liebertianum* Engl. (N. O. Burseraceæ), the bark of which yields a resin that much resembles olibanum; *Erythrophleum guineense* Don. (N. O. Leguminosæ), the bark of which contains Erythroplœin; and *Cordyla africana* Lour. (N. O. Leguminosæ), which yields an edible fruit.

R. T. Baker describes † two new species of *Eucalyptus:* (1) *E. dextropinea*, the volatile oil (0.85 %) of which consists largely of dextro-rotatory pinene, eucalyptol being absent: (2) *E. lævopinea*, the volatile oil (0.85 %) being made up largely of lævo-rotary pinene, but containing neither eudesmol nor eucalyptol.

The Strychnos species of Africa have been examined by E. Gilg, ‡ who divides them into two groups: (1) those with edible fruits: *Strychnos unguacha* A. Rich. (*S. innosa* Del.), *S. Quagua* Gilg, *S. cerasifera* Gilg, *S. Tonga* Gilg, also two species related to the latter whose fruits are no doubt eaten, *S. Welwitschii* Gilg and *S. cocculoides* Baker. (2) Those with poisonous fruits: *S. Icaja* Baill., *S. Kipapa* Gilg, *S. pungens* Solered., possibly also *S. spinosa* Lam. and

*Notizbl. d. Berl. Bot. Gart., 1899.
†Proc. Linn. Soc. N. S. W., 1898.
‡Notizlb.. d. Berl. Gart., 1899, No. 177.

S. Dekindtiana Gilg. These species do not contain, according to Thoms, any of the alkaloids found in nux vomica, but contain a bitter principle, not alkaloidal in character. From specimens * collected by Mr. and Mrs. Phillips it appears that the plant recognized by the Somalis as being the source of myrrh is that figured in Bentley and Trimen's 'Medicinal Plants.'

David Hooper † records the fact that when *Psychotria Ipecacuanha* is grown in phosphatic manure in India it produces double the amount of root (by weight) than grown in ordinary soil.

Unganda Aloes ‡ corresponds, according to W. A. H. Naylor and J.J . Bryant, approximately to the characters and tests of Cape Aloes.

It has been ascertained by J. Moir § that when *Scabiosa succisa* L. (N. O. Dipsaceæ) is chewed by cattle it causes violent inflammation of the mouth and tongue.

A. Davidson ‖ records the fact that *Solanum Xanti* A Gray, a plant of California, and the leaves of the common cultivated fig produce eruptions on delicate skins when brought in contact therewith. The seeds ¶ of an Euphorbiaceous tree, *Omphalea megacarpa* contain an oil which is mild and tasteless and which acts as a purgative producing its action in about 3 hours.

MEDICINAL PRINCIPLES.

A NEW alkaloid † has been discovered in stavesacre (*Delphinium Staphisagria*) by F. B. Ahrens, which he calls *Stapisagroin*. It does not give any of the reactions for the alkaloids hereto-fore found in *Delphinium*.

E. Kauder ** finds in *Anhalonium Lewinii*, besides mescalin, anhalonidin and lophophorin two other bases, viz: *Pellotin* and *Anhalomin*.

The *Kampferid* †† previously isolated by E. Jahns from the alcholic extract of galangal root has been further studied by Ciamician and Silber. They describe it as occurring in shining yellow crystals (M. P. 227–229° C.), which are odorless and tasteless.

The coloring principle (*Scoparin*) of *Spartium Scoparium* L. has been examined by Perkin.* He believes it to be probably methoxy-vitexin and finds that when digested with hydriodic acid it yields, besides methyl-iodide, a new coloring principle (*Scoparein*) which differs from Scoparin in possessing marked tinctorial properties.

The dried flowers of *Datura alba* from China have been examined by O. Hesse † and he finds them to contain 0.51% of hyoscine ($C_{17}H_{21}NO_4$), 0.03% of hyoscyamine and 0.01% of atropine. The hyoscyamine, while similar to that in *Hyoscyamus*, is not identical with the *Scopolamine* of Schmidt.

The active principle ‡ in the root of *Calliandra grandiflora* Benth., a leguminous shrub of Brazil and Mexico, appears to be, according to the researches of Duyk, a saponin, which he has called *caliandrin*. Internally it acts as an irritant and emetic. The poisonous principle (*temulin*) contained in the seeds of Darnel (*Lolium temulentum*) is ascribed by P. Guerin § to the presence of a fungus. The mycelia of this fungus were also present in two other poisonous species of *Lolium*.

Further investigations, by J. D. Fillipo, ‖ upon the alkaloid in the bark of *Tetranthera citrata* show that it has probably the constitution $C_{16}H_{11}(OCH_3)_3(OH)_2.NH_1$ and that its action is similar to, but less toxic than, strychnine.

A crystalline principle has been obtained from the fruits of *Capsicum annuum* by Micko ¶ which he considers to be the active principle of *Capsicum*. The crystals are white; M. P. 6—3 63.5°C.; formula $C_{18}H_{28}NO_3$. According to H. Molisch,** in the transformation of indican into indigo-blue in Indibopera, oxygen appears indispensable, and a number of bacteria and fungi accompany the reaction.

HENRY KRAEMER.

* Pharm. Jour. (London), 1899, p. 295.
† Ibid., p. 384.
‡ Ibid., p. 296.
§ Vet. Rec., 1899, p. 524.
‖ Therap. Gaz. 1899, p. 86.
¶ Ber. d. D. Chem. Ges., 1899, p. 1581.
** Arch. d. Pharm., 1899, p. 3.
†† Chem. Centralbl., 1899. p. 1041.

* Proc. Chem. Soc. 1899, p. 123.
† Südd. Apoth. Zeit., 1899, p. 2.
‡ Bull. Comm., 27, 81; through Pharm. Jour., 1899, p. 335.
§ Morot's Jour. de Bot., 1898, p. 230; through Ibid., p. 251.
‖ Arch. d. Pharm., 1899, p. 601.
¶ Zeitschr. f. Nahr. u. Genuss., 1898, No. 5.
** Sitz. k. Akad. Wiss. Wien.; through Pharm. Jour., 1899, p. 251.

THE DECENNIAL OF CLARK UNIVERSITY.

CLARK University has celebrated its decennial in a manner worthy of a university devoted to the advancement of science. The lectures, of which we may be able to publish abstracts later, were as follows: Professor Ludwig Boltzmann, of the University of Vienna, on the 'Principles and Fundamental Equations of Mechanics'; Professor Picard, of the University of Paris, on 'Differential Equations' and on 'Analytical Functions'; Professor Angelo Mosso, of the University of Turin, on 'The Relation between Muscular Exercise and the Development of Mental Power' and on 'Bodily Disturbances accompanying the Emotions;' Professor Santiago Ramon y Cajal, of the University of Madrid, on the 'Structure of the Visual Cortex of the Human Brain,' and Professor August Forel, of Zürich, on 'Hypnotism' and on 'Arts.'

There was a large number of American men of science in attendance at the lectures. The mathematicians and physicists included Professors A. A. Michelson, E. W. Morley, E. H. Hall, Maxime Bôcher, E. B. Fine, W. F. Magie, M. I. Pupin and Mr. C. S. Pierce. Among physiologists, psychologists and neurologists present were Professors H. P. Bowditch, C. S. Minot, William James, Josiah Royce, Hugo Münsterberg, J. Mark Baldwin, J. McKeen Cattell, W. L. Bryan, M. W. Calkins, A. H. Daniels, W. O. Atwater, Wm. A. Locy and Drs. G. H. Parker and Ira Van Gieson.

PROFESSOR BEECHER'S GIFT TO YALE UNIVERSITY.

THE President of Yale University announces in his annual report an exceedingly valuable gift to the University, received on the 19th of June, from Professor Beecher, a description of which is contained in the following letter addressed by him to the Corporation:

To the Corporation of Yale University:

In grateful recognition of the honors and favors conferred upon me during my connection with the University, I herewith beg to offer unconditionally, as a gift to the Peabody Museum, my entire scientific collections.

These collections were made previous to my coming to New Haven, and represent the results of twenty years' labor. They were collected wholly by me in the field and at my own expense, and comprise upwards of one hundred thousand specimens, mostly of invertebrate fossils.

The collections represent:

1. The fauna of the Upper Devonian and Lower Carboniferous in Pennsylvania.

2. The fauna of the Middle Devonian of western New York.

3. The fauna of the Lower Devonian of central and eastern New York.

4. A small series from other geological horizons.

5. About five hundred type specimens, which have been illustrated and described in the volumes of the Paleontology of New York, in the Geological Survey of Pennsylvania and in various scientific periodicals.

The ground covered by these collections is now almost wholly unrepresented in the Museum, and the number of types of fossil invertebrates is far greater than at present belonging to the Museum. There are hundreds of specimens unique for their perfect condition of preservation and for their careful preparation to show delicate structural details. No other single collection in America is so rich in series showing the life histories of species from the embryonic to the adult state.

I have the honor to be

Very respectfully yours,

CHARLES EMERSON BEECHER.

PROPOSED INSCRIPTIONS FOR THE STATUE OF DARWIN.

THE London *Academy* has asked for an inscription of not more than forty words suitable to be engraved on the statue of Charles Darwin recently erected. Of those received they regard the following, composed by Mr. Edwin Cardross, 22 Seymour street, Portman square, W., as the best:

"Charles Darwin, the great naturalist, memorable for his demonstration of the law of evolution in organic life, achieved by scientific imagination, untiring observation, comparison and research; also for a blameless life, characterized by the modesty, 'the angelic patience of genius.'"

Other proposed inscriptions were:

"In memory of Charles Darwin, theorist, philosopher, psychologist. A student of Nature, he searched for the truth, endeavoring to understand the beginning of all things, thus to make clearer the mysteries of Nature, the revelation of which was his ambition."

[G. W., Hull.]

"To the memory of Charles Darwin, whose extraordinary abilities and indefatigable energies, ordered

by steadfast honesty of purpose and inherent modesty, combined to make him the greatest scientist of the age, the first exponent of the theory of human evolution." [J. D. Q., Shrewsbury.]

"Charles Darwin, whose patient and acute observation compelled Nature to reveal her great secret, the origin of species.

'He never turned one inch out of his course to gain fame.'" [W. E. T., Caterham.]

"Charles Darwin, on patient experiment and observation, founded a theory of evolution, which, in explaining the successive appearance of more complex forms of life in the world's history, has furnished a basis and example for all modern scientific investigation." [J. D. A., Ealing.]

The men of letters who have, it may be assumed, written the above do not appear to appreciate very fully Darwin's work. Can any of the readers of SCIENCE suggest a better inscription?

SCIENTIFIC NOTES AND NEWS.

PRESIDENT SCHURMAN, of the Commission to the Philippines, is returning to America, in accordance with his original plans, and will arrive in August. Professor Worcester will for the present remain at Manila.

DR. G. AGAMENNONE has been appointed Director of the Geodynamic Observatory of Rocca di Papa, near Rome, as successor to the late Professor M. S. de Rossi.

THE various field-parties in connection with the Geological Survey of Canada comprise the following staff, viz.: Mr. R. G. McConnell, Yukon Territory, Gold Mining District; Mr. R. W. Brock, Rossland Mining District and West Kootenay; Mr. J. McEvoy, East Kootenay Mining District; Ontario Gold Fields, Mr. Wm. McInnes; Ottawa Valley Mining District, Dr. R. W. Ells; Manitoba, Mr. D. B. Dowling; Great Slave Lake, Dr. Robert Bell; Nova Scotia Coal Mining Districts, Mr. Hugh Fletcher; Gold Mining Districts of Nova Scotia, Mr. E. R. Faribault.

HENRY B. KÜMMEL, PH.D., who has been assistant professor of physiography at Lewis Institute, Chicago, since the foundation of the Institute, has recently been appointed Assistant State Geologist of New Jersey. Dr. Kümmel has been an Assistant on the Survey for several years, and for the last four years has devoted his attention to a study of the Triassic of New Jersey, on which he has already published several papers.

AT a special meeting of the court of Victoria University at Owens College, Manchester, on June 22d, the honorary degree of Doctor of Science was conferred on Dr. J. Clifford Allbutt, F. R. S., Regius professor of medicine at Cambridge University, and on Dr. H. E. Schunck, F. R. S., the author of numerous papers on the chemistry of organic coloring matter.

SIR WILLIAM TURNER THISELTON-DYER has been elected to an honorary studentship at at Christ Church College, Oxford.

THE University of Dublin has conferred the degree of Doctor of Science on Professor A.R. Forsyth, Sadlerian professor of pure mathematics in Cambridge University.

MR. JOHN R. SWANTON, of Columbia University, is visiting the Teton Indians of South Dakota, in order to carry on linguistic researches among this tribe.

PROFESSOR MARK W. HARRINGTON, of the Weather Bureau, who has recently been assigned to stations in the West Indies, has resigned.

WE regret to record the death, on July 2d, of Sir William Henry Flower. Sir William Flower was born at Stratford-on-Avon in 1831, and was educated at University College, London. He served as assistant surgeon during the Crimean War, and later was for two years assistant surgeon in the Middlesex Hospital. He then became conservator of the Museum of the Royal College of Surgeons, and in 1870 he was elected Hunterian professor of anatomy. This chair he held until 1884, when he became Director of the British Museum of Natural History. He resigned the directorship in 1898 on account of ill health. His contributions to science are numerous and important; chief among these are the 'Introduction to the Osteology of Mammalia,' the third edition of which appeared in 1885; 'Introduction to the Study of Mammals, Living and Extinct' (1891); 'The Horse, a Study of Natural History' (1892); and 'Essays on Museums' (1898). Sir William Flower was a Past President of the British Association for the Advancement of

Science (1889) and of the Anthropological Institute (1883–85), and was at the time of his death President of the Zoological Society of London. He was a Knight of the Prussian order 'Pour le mérite,' a correspondent of the Institute of France, and held honorary degrees from a number of learned institutions.

WE learn from *Nature* that news has been received of the death of Mr. John Whitehead while on a scientific mission in the Island of Hainan. Mr. Whitehead left England in the autumn of last year for the purpose of exploring the less known islands of the Philippine group and obtaining a collection of their fauna for the British Museum (Natural History).

THE death is announced of Sir Alexander Armstrong, F.R.S., the discoverer of the Northwest Passage. Sir Alexander spent five successive years in the Arctic regions in the search for Sir John Franklin. From 1869 to 1880 he was Director-General of the Medical Department of the British Museum. He was the author of 'A Personal Narrative of the Discovery of the Northwest Passage,' and 'Observations on Naval Hygiene.'

MR. HENRY WOLLASTON BLAKE, a well known engineer, died on June 28th. Mr. Blake had been Fellow of the Royal Society for fifty-five years. He was an original member of the Institution of Civil Engineers, of the Institution of Mechanical Engineers, and of the British Association.

WE also regret to record the death of Lieutenant Charles William Baillie, Superintendent of the Marine Department of the Meteorological Office of Great Britain, and of Dr. Hugo Weidel, professor of chemistry in the University of Vienna.

PROFESSOR WILLIAM LIBBEY, of Princeton University, has gone to Sidney, Nova Scotia, whence he will embark on about the 20th instant on the steam whaler *Diana*, of the Peary relief expedition, for Inglefield Gulf. Professor Libbey is accompanied by Dr. A. E. Ortmann, of Princeton University. Among other scientific work they intend to carry on deep-sea dredging.

DR. ROBERT STEIN, of the United States Geological Survey, accompanied by Dr. Leopold Kann, has also arranged to embark with the expedition, leaving Sidney, Nova Scotia, about July 20th, for exploration in Ellesmere Land. They plan to spend the autumn in surveying and collecting along the coast, and to winter on the island.

DURING the present year field work of the Jesup North Pacific expedition of the American Museum of Natural History is being carried on in the State of Washington, in British Columbia and in southeastern Siberia. It is expected that Dr. Berthold Laufer will bring his researches on the Island of Saghalin and on the Amoor river to a close during the autumn of the present year. Mr. Harlan I. Smith is conducting an archæological investigation of the shell heaps of Puget Sound, and will, later on, continue his work in southern British Columbia. Mr. James Teit is carrying on ethnological researches among the Lillovet Indians.

THE Anthropological Department of the American Museum of Natural History has sent out two investigators to conduct researches among the Indian tribes of the West. Mr. Roland B. Dixon, assistant in anthropology at Harvard University, is visiting the Concow tribe of California, and Mr. Alfred L. Kroeber, fellow in anthropology at Columbia University, is visiting the Cheyenne and Arapahoe Reservation.

THE Belgian Academy of Sciences announces the subjects of its prizes for the year 1900. Five are set in the physical sciences and five in the natural sciences, for each of which a gold medal of the value of 600 frs. is offered. The papers must be received not later than the 1st of August, 1900, and must be written in French or in Dutch. Further details may be obtained from the Secretary of the Academy, Brussels.

THE Science Club medal of the University of Wisconsin for the year 1899 has been awarded to Mr. Carol Hambuechen, of Milwaukee, for a thesis entitled 'An Experimental Study of the Corrosion of Iron under Various Conditions.' It is the first award of this medal, which has been designed by Thomas Moring, of London, and is to be awarded annually to the member of the senior class who presents for his thesis the best original investigation.

The Anatomical Society of Great Britain and Ireland met at Cambridge on July 8th.

We learn from the *British Medical Journal* that on June 27th, in the presence of a number of eminent official, academic and scientific men, Virchow formally opened the new pathological museum which bears his name and has been built under his superintendence. It has cost about 560,000 Marks, and contains a collection of more than 20,000 specimens, collected almost wholly by Professor Virchow himself, and representing the history of pathology during the past half century. Professor Virchow delivered a speech in which he pointed out that while foreign countries, especially England, had long preceded Germany in anatomical researches the Fatherland could now rival them on that ground.

At a sitting of the Municipal Council of Paris, M. Bertillon has been dismissed from his position as Chief of the Indentification Service at the Perfecture of Police, owing to his report in 1894 on specimens of Dreyfus's hand writing, submitted to him for comparison with the bordereau by the Minister of War. M. Gobert, expert of the Bank of France, who was first appointed to examine the matter, reported that the bordereau might well have been written by another person than the one suspected. M. Bertillon's report ran as follows: "If one sets aside the hypothesis of a document very carefully forged, it clearly appears that one and the same person wrote the letter (*i. e.*, the bordereau) and the pieces communicated for comparison."

Judge Colt, of the United States Circuit Court, in Boston, has reversed the decision of the Board of Appraisers, which held that surgical instruments imported to this country were dutiable. He holds that the instruments are not dutiable, being 'scientific instruments' within the meaning of the law.

UNIVERSITY AND EDUCATIONAL NEWS.

The *British Medical Journal* states that at the special meeting of the Senate of the University of London summoned for June 28th a long discussion took place upon a motion submitted by the Chancellor (Lord Kimberley) accepting the proposals of the government to transfer the University from Burlington Gardens to the Imperial Institute. The meeting was an unusually large one, and sat for two hours, but finally adjourned without coming to a decision. It is understood that great reluctance was expressed to surrendering the present buildings, but that the majority favored the acquisition of some portion of the Institute buildings to meet the demands of increased accommodation for teaching and laboratory work, such as must speedily follow the passing into law of the statutes framed by the Royal Commission.

At the University of Wisconsin Dr. W. H. Hobbs, assistant professor of mineralogy and petrology, has been promoted to a full professorship, and Robert W. Wood, instructor in physics, to be an assistant professor.

Professor Rush Rhees, of Newton Theological Seminary, has been elected President of the University of Rochester. He will assume office in July, 1900, which will be the fiftieth anniversary of the founding of the institution.

Of the eight fellowships given annually by the University of Virginia, two have been awarded in the sciences as follows: *Mathematics*, T. G. Johnson; *Agriculture*, W. F. Maret. The fellowships are of the value of $300 a year, and each fellow is expected to teach one hour daily in the University and to devote the remainder of his time to advanced study and research.

Professor E. A. Schaefer, F.R.S., for fifteen years Jodrell professor of physiology in University College, London, has been elected to the chair of physiology in the University of Edinburgh.

At a meeting of the Council of University College, London, held on Saturday, June 17th, Professor Montelius was appointed Yates lecturer in archæology for the year 1900.

Dr. Schenck, docent in physiology in the University at Würzburg, Dr. Martin, docent in anthropology in the University of Zurich, and Dr. Blaschke, honorary docent in mathematics in the Technical Institute of Vienna, have been promoted to assistant professorships.